Influence of loading history on subsurface architecture and subsidence potential for the historical city of Gouda, The Netherlands.

Simon van Laarhoven

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Author:
Simon van Laarhoven

Student number:
3947343

Supervisors:
dr. Esther Stouthamer – UU
dr. Gilles Erkens – UU & Deltares

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Preface

This study was conducted as a graduation research for the Master Program “Earth Surface and Water” at Utrecht University. The subject for this MSc thesis was established in cooperation with Deltares, where a larger project on subsidence in Gouda, including economical and stakeholder analyses, was executed.

I am glad to say that the subject of this study still motivates and interests me after almost a year of hard work and despite several setbacks and delays. I have, most certainly, learned a lot during this MSc research; ranging from independently setting up an entire fieldwork to the academic level of thinking needed to bring this thesis to a successful end. Therefore, I want to thank both Deltares and Utrecht University for the possibility to work on this subject.

Furthermore I want to thank both my supervisors for the motivating and inspiring guidance throughout my MSc research. I am also glad for all the assistance a received during both the fieldwork campaigns and a want to thank everyone for their help (Arjan van Eijk, Gilles Erkens, Livio Ronchi, Mark Eikelboom, Esther Stouthamer, Tim Winkels, Bas van der Meulen, Laura Coumou, Steven Weisscher, Joris Tholen, Axel Deijns, Ivo Naus, Erik van Onselen and Sam Huizing). Lastly, I want to thank Wim Hoek and Sanneke van Asselen for setting me up in the lab and everybody from Deltares and Utrecht University who helped me with questions concerning data availability or iMOD (Henk Kooi, Liduin Burgering and Peter Vermeulen from Deltares and Philip Minderhoud from Utrecht University).

Summary

The city of Gouda has been dealing with subsidence for about 750 year, since its founding in 1272. The city was built out in a cultivated peat swamp. The surface water drainage needed for land cultivation caused oxidation and increased loading of the peat, which induced subsidence together with the load added by the urbanization. From this subsidence, several problems such as increased flood risk arose. Traditionally, the land surface would be raised or the shallow water level would be lowered to decrease the risk of flooding from the canals. However this induced a vicious cycle, as the added deposits and lowering of the water level increased the stresses on the peat, which caused additional subsidence.

Currently, a point is reached at which these traditional solutions no longer realize their purpose. If the groundwater level would be lowered further in certain regions, wooden pile foundations will start to rot, as they would become aerated. Therefore, new strategies to deal with subsidence have to be devised. However, very little is known about the processes causing the subsidence in Gouda, or about the current subsidence potential of the peat layer.

This study therefore aimed to identify the main mechanisms responsible for the observed subsidence, and how these mechanisms relate to loading history and applied overburden. Additionally, subsidence is greatly dependent on the subsurface architecture. This is why a 3D lithostratigraphycal model of the subsurface was constructed in iMOD, which generates insight in the subsurface build-up and can be used for future modeling studies.

To assess the main driving mechanisms for the subsidence in Gouda, a literature study on the mechanisms that cause subsidence was combined with the depth of the peat layer, relative to the lowest groundwater levels. Based on this, the conclusion was that a substantial part of the observed subsidence in Gouda is caused by urban loading, while oxidation does no longer contribute to the subsidence observed in the city.

The complex history of urban loading causes a large spatial difference in the currently applied load, which can only be captured by an accurate subsurface model. The data required to construct such a model was obtained by combining existing data and data gathered during an urban fieldwork.

In order to evaluate the relation between the loading history and subsidence potential, the current degree of consolidation of the underlying peat in three regions was compared. The regions were chosen based on their loading history; 1) the inner city with a history of 750 years of extensive loading, 2) the adjacent district of “Korte Akkeren”, in which urbanization started around 1860, and 3) a rural area, which has seen no urban influence. The average degree of consolidation was computed for four sampled locations, using an empirical relation between the organic matter content, the dry bulk density and the consolidation. Afterwards, the subsidence potential was calculated for the different regions using the average consolidation degrees of each sampled location and the response to additional applied loading.

This study shows an increase in consolidation degree from the rural area towards the inner city. Vice versa, a decrease in subsidence potential is found in this direction. The estimated subsidence potential indicates a potential of 3.5 m for the rural area and 1.2 to 0.9 m in Korte Akkeren, if these areas were loaded similar to the inner city. Additionally, the constructed lithostratigraphic 3D model proved a great improvement on the nation-wide subsurface model of the Netherlands (GeoTop), which largely overestimated the amount of peat and underestimated the amount of anthropogenic deposits by approximately 60% and 55%, respectively.

In conclusion, the results acquired in this study give a first indication of the subsidence potential for the different sub-regions of the research area. Additionally, the connection made between the subsidence potential and the subsurface build-up enables a rough estimation of the subsidence potential for the entire study area.

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1 Introduction

Since its founding in 1272, the historical city of Gouda has been dealing with subsidence caused by oxidation and consolidation of the peat on which the city is built (Abels et al., 2002). The city of Gouda is currently dealing with severe problems emanating from the long history of land subsidence. These problems range from damaged buildings and foundations to increased flood risk during downpours (Het Gouds Watergilde, 2016) and flooded cellars due to the high groundwater table. Lowering of the groundwater level to decrease the flood risk or to cope with the problems concerning flooded cellars, is no longer an option due to the presence of wooden pile foundations. These wooden piles would start to rot when the groundwater table is lowered, causing substantial damage to buildings. Raising the land surface using clastic materials, as was common in the past, but proved unsustainable, as this induces more subsidence, increasing the need to lower the groundwater table.

Besides Gouda, there are many more cities in different deltas experiencing subsidence-related issues. Syvitski et al. (2009a) found that most of the deltas they studied are subsiding much faster than sea-level is rising. This is also true for the Rhine-Meuse Delta, where the average subsidence rate in the western peat areas is estimated to be about 10 mm/yr (Essink & Kooi, 2011). In contrast, a current sea-level rise of 1.8 mm/yr is observed in the Netherlands (KNMI, 2014).

Most subsidence research focuses on measuring subsidence rates (e.g. Abidin et al., 2015; Erban et al., 2014; Higgins, 2016; Syvitski et al., 2009). However, devising resilient strategies to cope with subsidence requires modeled predictions, for which knowledge on the underlying mechanisms is of key importance. In turn, the mechanisms causing subsidence depend greatly on the lithological architecture and geotechnical properties of the subsurface (Minderhoud et al., 2015).

For Gouda, geological knowledge is also critical to unravel the subsidence signal and to find new strategies to deal with subsidence. However, little is known about the subsurface architecture of Gouda. This makes it impossible to assess the importance of individual drivers and to, subsequently, determine the subsidence potential. Consequently, additional research on the lithological subsurface build-up, the contribution of individual mechanisms and drivers to the total subsidence, and subsidence potential was required.

The main aim of this study was, therefore, to assess the subsidence potential of Gouda and to unravel which driving mechanisms are causing the observed subsidence signal and quantify their contribution. To find the main driving mechanisms or the subsidence potential of the urban area, additional knowledge on the subsurface build-up was needed, as the subsurface build-up largely governs subsidence.

Consequently, the second aim of this study was to construct an accurate lithostratigraphic 3D model of the subsurface of Gouda. Such a model will, additionally, enable the future subsidence modeling needed to come up with new resilient strategies to cope with subsidence in Gouda. A sub-goal during the creation of the subsurface model was to assess the added model accuracy when more data and geological insight were incorporated during construction. It was expected that the newly build 3D model would be significantly more accurate than the widely used publically available subsurface model of the Netherlands (GeoTop; TNO, 2014), as the delta wide model uses a lower data density and is based on statistics rather than geological development of an area.

The final aim of this thesis was to determine the influence of spatial differences in subsurface architecture, load distribution and the current degree of consolidation on the subsidence potential and subsidence history of the research area. The influence of these variables was assessed using the constructed 3D representation of the subsurface in combination with consolidation measurements and the loading history of different sub-regions of the research area.

To achieve the aims of this study, background information on the genesis of the subsurface and the history of the city of Gouda was gathered and outlined (Chapter 2). Additionally a literature research on the difference mechanisms and drivers causing subsidence was performed (Chapter 3), to acquire more insight in the processes at hand. To create the lithological subsurface representation needed to assess the contribution of the different subsidence mechanisms and driver, a lithological dataset was gathered consisting of existing and newly acquired lithological core descriptions (section 4.1). This dataset enabled the construction of the 3D subsurface model (section 4.3.1) and, subsequently, the unraveling of the subsidence signal (section 4.3.2).

During the fieldwork executed to gather the lithological data, several peat samples were gathered. These samples were tested for their dry bulk density and organic matter content to derive their current consolidation stage (section 4.2). Based on the current degree of consolidation, the subsidence potential of the different sampled core locations was quantified (section 4.3.3).

The two paragraphs above give the main approach on which the methods of this study are based (Chapter 4). Furthermore, the results, discussion and conclusions of this thesis can be found in chapters 5, 6 and 7, respectively.

2 Geographical and geological setting

The city of Gouda is situated along the Hollandse IJssel River, within the western peat area of the Netherlands (Figure 1). This area used to be a swamp where urban development was impossible, until the area was cultivated around 1100 AD (Abels et al., 2002). This study focuses in particular on the inner city of Gouda, the Korte Akkeren district and the adjacent rural area (Figure 1). These three sub-areas were chosen because of their different loading history and the continuous transition from the oldest to a younger urban district to the rural area.

In section 2.1 the urban history of these three areas are shortly discussed, followed by the observed subsidence rates in each sub-area. In section 2.2 the geological history of the general region is described (section 2.2).

2.1 Geographical setting

The inner city was the first area to be occupied. The city centre developed on the natural levee along the natural peat drainage channel, known as the Gouwe. The initial settlement is believed to have grown from the harbor outwards (Figure 1) (Abels et al., 2002). It is unknown when the first construction activity commenced, although this had to be before Gouda gained its city rights in 1272 AD. Until 1310 AD the expansion of Gouda was concentrated around the market. Afterwards, the inner city gradually grew, until it reached its maximum expansion around 1350 AD (Abels et al., 2002).

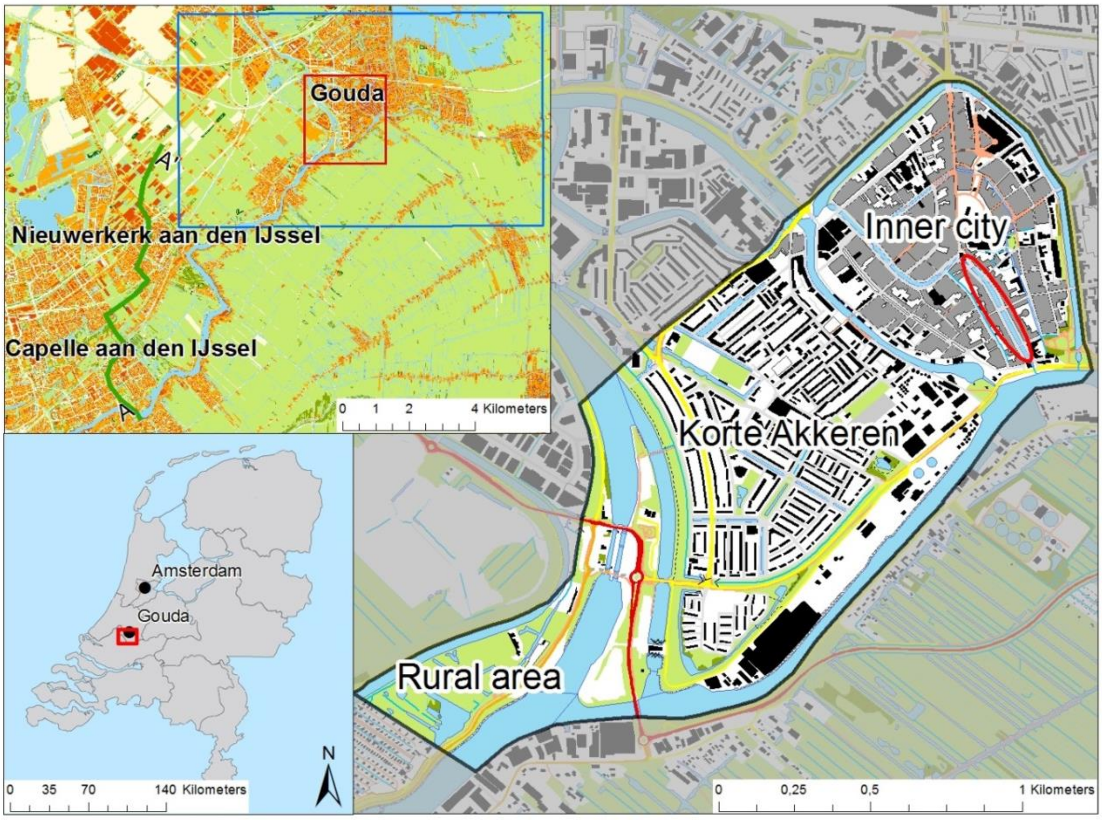


Figure 1 Right: indication of the study area (black line), the old harbor (red ellipse) and the three sub-areas. Lower left: position of Gouda within the Netherlands. Upper left: location of Gouda with respect to the region, including the location of cross-section A-A' (green line; Figure 4) (Hijma et al., 2009) and a blue frame indication the boundaries of Figure 6.

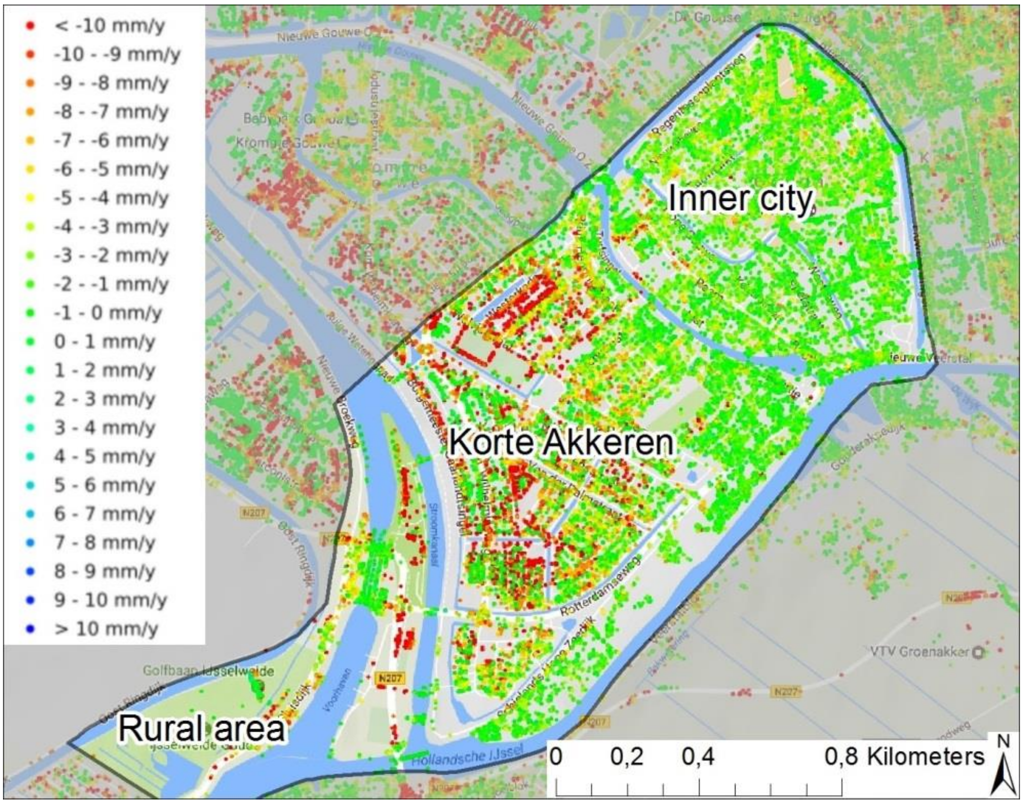


Figure 2 Linear land surface subsidence rates [mm/yr], based on 80 InSAR persistent-scatterer images, taken between November 2013 and November 2016 by the TerraSAR-X satellite (SKY GEO, 2017).

The second district of the study area is Korte Akkeren. During the 17th century only a few houses were present in the most northeastern corner of the district (Goudse Canon, 2009). Around 1860 the first houses were built along the canal separating the inner city and Korte Akkeren. Following the construction of two factories, new houses were constructed to house all workers. This caused a gradual expansion of Korte Akkeren in southwestern direction up to 1956 AD (Goudse Canon, 2009).

The last sub-area studied is the rural area to the southwest of Korte Akkeren. This area has known relatively little loading, as it is not urbanized. For the last 25 years, a golf course has been present in the rural area indicated in Figure 1. Although, the presence of the golf course does entail human activities in the rural area, no land raising was implemented, causing a low overburden on the peat.

Land subsidence rates differ greatly between and within each of the three studied sub-areas. Figure 2 illustrates the linear subsidence rates based on InSAR data obtained over the period of 2013 to 2016 (SKY GEO, 2017). This figure shows a differential subsidence pattern with largest subsidence rates occurring within Korte Akkeren and relatively low rates and less spatial difference within the inner city.

In Korte Akkeren, 90% of the measured subsidence rates range between 0 and 10.7 mm/yr (Appendix 1), but extremes up to 41.1 mm/yr are also observed (Table 1). Whereas, in the inner city, 90% of the measured subsidence rates range between 0 and 4 mm/yr (Appendix 1), with a few observed extremes up to 15 mm/yr (Table 1). In the rural area the subsidence rates are only 0.1 to 1.3 mm/yr, making this the most stable region.

Table 1 Statistics of the subsidence rates measured using InSAR(SKY GEO, 2017), for the three sub-regions within the research area.

		Inner City	Korte Akkeren	Rural
Number of points		11011	15889	5
Subsidence rate [mm/yr]	Mean	2.29	4.74	0.40
	Mode	2.20	0.80	--
	Max	15.00	41.10	1.30
	Min	0.00	0.00	0.00
	Std	1.54	4.74	0.52

2.2 Geological development of the study area

The study area is situated in the North Sea Basin, which is subsiding at a rate of approximately 0.04 mm/yr near Gouda (Kooi et al., 1998). Together with the sea-level rise since the last glacial maximum (Weichselien), this caused the generation of accommodation space in the North Sea Basin.

Figure 3 illustrates how the accommodation space near Gouda was filled throughout the late Pleistocene and Holocene. During the Weichselien fluvial sands and gravels were deposited over broad plains (Kreftenheye Formation), which were later covered by clayey Pleistocene floodplain deposits (Wijchen Member). When the Holocene started channels belts were much narrower, only locally depositing sandy deposits. During this period, mainly clayey sediments were deposited in the floodplains (Figure 3). After a certain period, the dominance of fluvial deposition decreased and peat was formed. On top of the peat, some relatively thin fluvial deposits are found again. The youngest deposits found in the area have an anthropogenic origin and are situated adjacent to the Hollandse IJssel (Figure 3).

In the following sections, the general description of the geological history will be discussed in more detail. Section 2.2.1 covers the history of the period dominated by fluvial deposition (Late Pleistocene and Early Holocene). Subsequently, section 2.2.2 describes the formation of the peat and the overlying fluvial deposits, followed by a discussion on the anthropogenic development of the region (section 2.2.3).

2.2.1 Late Pleistocene and Early Holocene fluvial deposition

During this last glacial period of the Pleistocene (Weichselien; 11.7 - 116 ka) the Scandinavian glaciers prograded to the south, but did not reach the Netherlands. Nevertheless, the progression of land ice did cause a drop in sea-level of about 110 m (Stouthamer, Cohen, & Hoek, 2015). Focusing on the sediments situated just below the Holocene deposits (Middle and Later Weichselien deposits), coarse sands and gravels were deposited during the Middle Weichselien (Pleniglacial). Throughout this period the Rhine followed a braided pattern, causing the coarse sands and gravels (Kreftenheye-5 deposits) to be deposited over a large plain (Figure 4A).

Throughout the Allerød interstadial, the Rhine followed a meandering river pattern. These meandering rivers incised into the Pleniglacial (Kreftenheye-5) deposits, as a result of the low base level (sea-level), caused by water storage in ice sheets (Stouthamer et al., 2015). Due to the incising rivers, the deposition of the Kreftenheye-5 sediments ceased, causing the top of these deposits to form a Pleniglacial terrace. Only during high peak discharge, the floodplain was flooded. This caused the deposition of a clay layer on the coarse grained Pleniglacial terrace. This layer is known as the Wijchen-layer, and consists of 0.5 to 1 meter of stiff blue-grey clays. Due to the long subaerial exposure of the Wijchen-layer, soil formation took place. This caused decalcification of the layer and the top to become darker in color (Stouthamer et al., 2015).

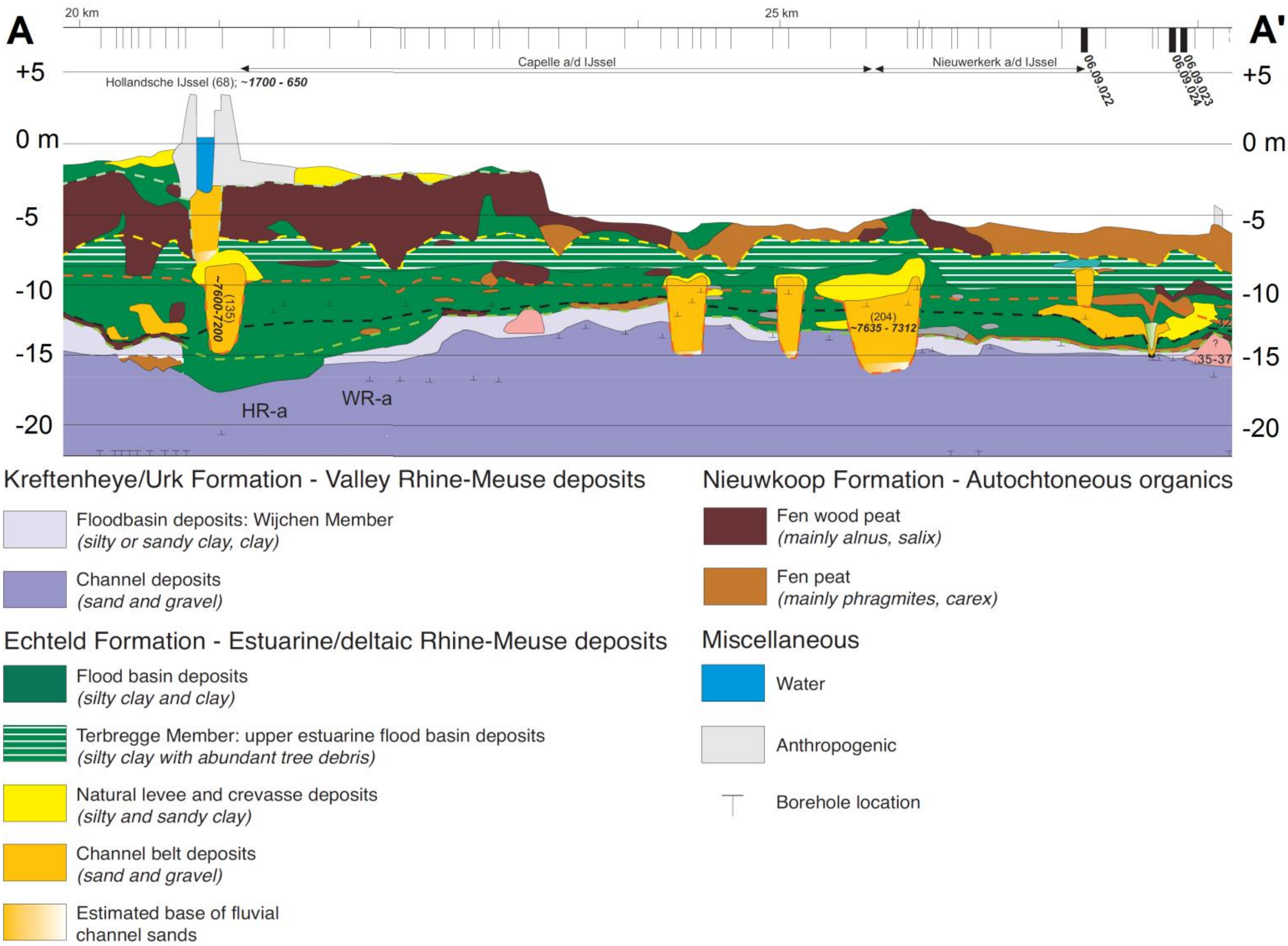
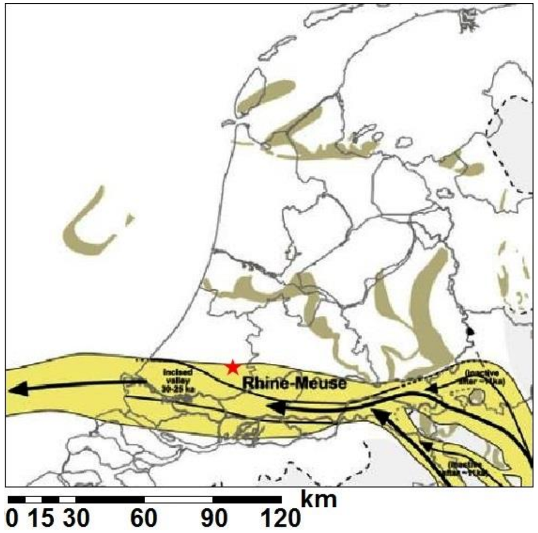
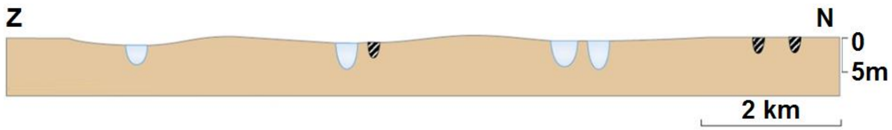
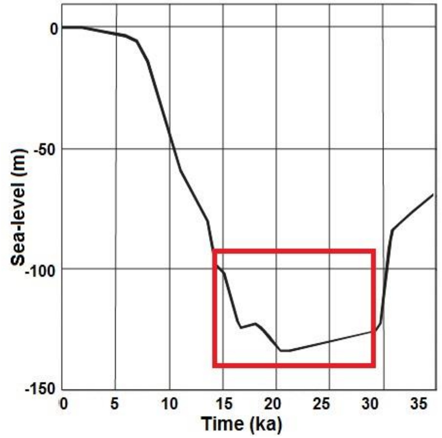
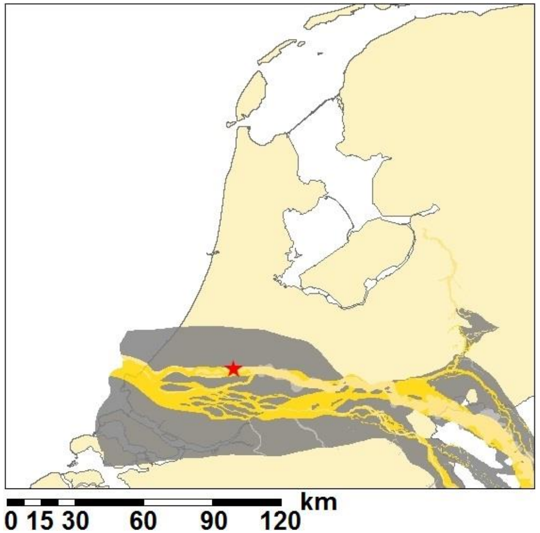
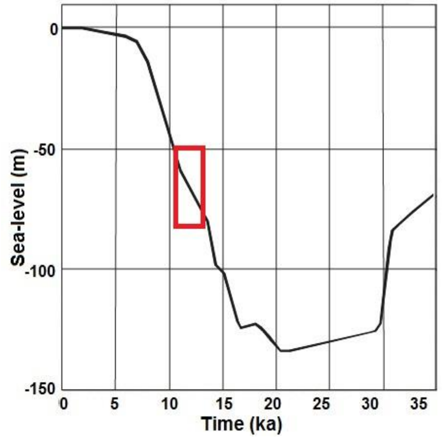


Figure 3 Part of the lithostratigraphic cross-section by Hijma et al. (2009), indicating the general subsurface build-up in the Gouda region. Location of the cross-section is illustrated in Figure 1.

During the Younger Dryas (stadial following the Allerød interstadial) the Rhine started braiding again, causing the formation of a new terrace at a lower level (Younger Dryas terrace) than the Pleniglacial terrace (Figure 4B). The braided river pattern caused the rivers to widen and erode their banks (Kreftenheye-5 deposits), causing a wide terrace to form a couple of meters below the Pleniglacial terrace (Stouthamer et al., 2015). The top of the lower terrace is marked by the top of the coarse sands, deposited in the braided river plain during the Younger Dryas (Kreftenheye-6).

During the Holocene (0 - 11.7 ka), the low lying Younger Dryas terrace started to fill up with fluvial deposits (Echteld Formation). This accretion was caused by the rising sea-level since the end of the Weichselien glacial period, causing the river base level to rise above the Younger Dryas level around the beginning of the Holocene, creating new accommodation space.

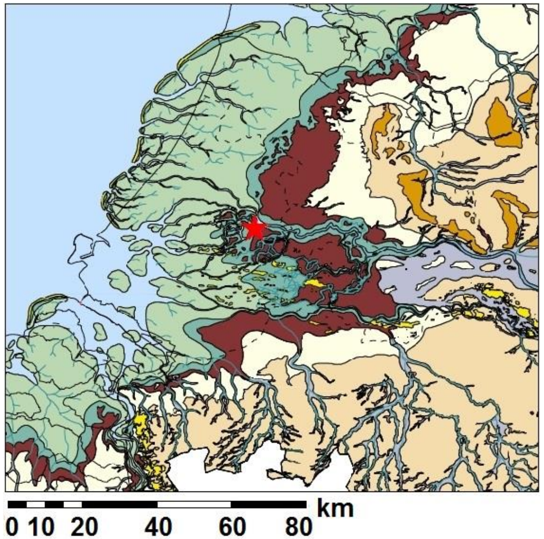
During the Atlanticum (sub period of the Holocene; 5700 to 8500 yr BP) the filling of the Younger Dryas terrace was completed (Figure 4C), enabling the Rhine to deposit its sediments on top of the Pleniglacial terrace. Additionally, the Rhine was now able to create new avulsions over the entire delta plain (Figure 6), creating different successive channel belts (discussed below).

Period	Paleogeographic map	**Cross-section** (Stouthamer et al. 2015)	**Sea-level**
A) **Weichselien:** **Late Pleniglacial** **14.7 - 28 ka**	 (Peeters et al., 2015)		 After Lambeck et al. (2014)
B) **Weichselien:** **Younger Dryas** **11.7 - 12.9 ka**	 (Cohen et al., 2012)		 After Lambeck et al. (2014)

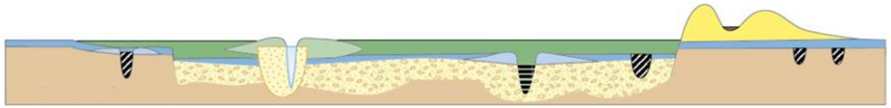
C)
Holocene:

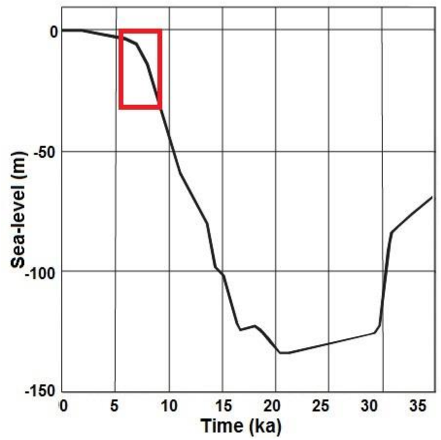
Atlanticum

5.7 - 8.5 ka



(Vos, 2015)



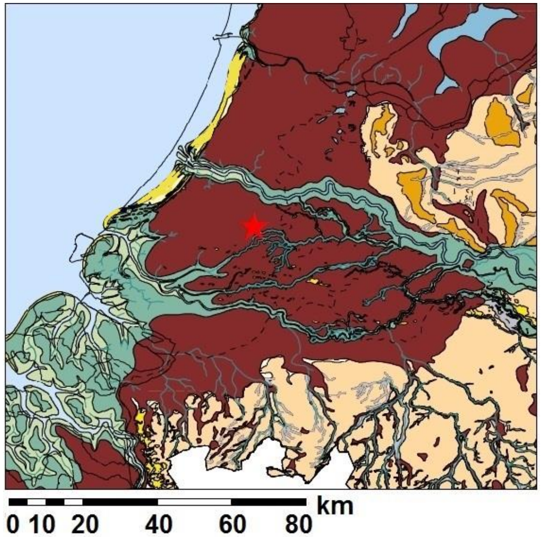


After Lambeck et al. (2014)

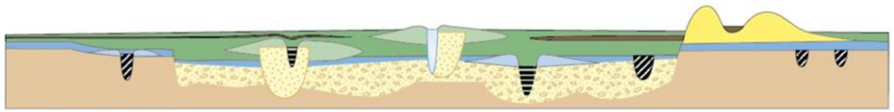
D)
Holocene:

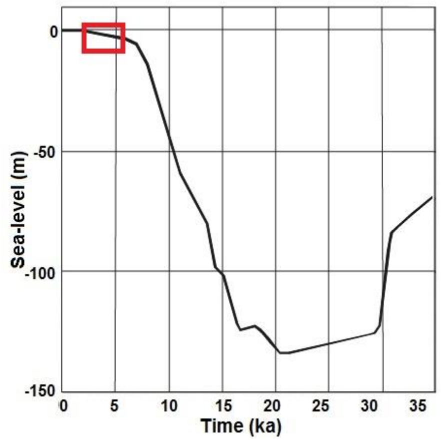
Subboreal

2.6 – 5.7 ka



(Vos, 2015)





After Lambeck et al. (2014)

Figure 4 Illustration of the general formation of the Pleniglacial and Younger Dryas terrace, during the Weichselien and Early-Holocene, and the further aggradation during the Holocene. This figure contains paleogeographic reconstructions (Cohen et al., 2012; Peeters et al., 2015; Vos, 2015), cross-sections(Stouthamer et al., 2015) and sea-level curves (Lambeck et al., 2014) for the Pleniglacial (A), Younger Dryas (B), Atlanticum (C) and Subboreal (D) period.

Paleogeographic map by: Peeters et al. (2015)	Gouda Channel belt Flow direction
Paleogeographic map by: Cohen et al. (2012)	Gouda Active meander belt Lateglacial floodplain area
Paleogeographic maps by: Vos (2015)	Gouda Freshwater areas Brackish and marine areas **PLEISTOCENE LANDSCAPE** Fluvial areas Pleistocene: sand areas, below 16 m -NAP Pleistocene: sand areas, between 16 en 0 m –NAP **HOLOCENE LANDSCAPE** *Coastal Dunes* High dunes Beach-plaine and dune valleys *Peat areas* Peat *Flooded areas* Intertidal areas: Fluvial flood plain and salt-marsh areas Salt-marsh levees
Cross-sections by: Stouthamer et al. (2015)	**Kreftenheye Formation** River dune deposits Floodplain deposits (Wijchen) Natural levee deposits Residual channel deposits Kreftenheye-6 bed deposits Kreftenheye-5 bed deposits **Echteld Formation** Floodplain deposits Natural levee deposits Residual channel deposits Bed deposits **Nieuwkoop Formation** Peat

Figure 5 Legends for the different paleogeographic maps and the cross-sections displayed in Figure 4.

Holocene channel belts

Five channel belts were present near Gouda during the last 8900 years. The oldest one is the Gouderak (active from approximately 8900 to 7900 yr BP) which runs exactly underneath the inner city of Gouda, according to the paleogeographic reconstruction by Cohen et al. (2012) (Figure 6). Due to the Holocene transgression, the Zuidplas channel belt gradually evolved from the flooding Gouderak system (active from about 7900 to 7300 yr BP; Cohen et al., 2012). This new channel belt was formed by a multi-channel system, which has two main channels in the Gouda region (Figure 6). This channel belt was abandoned around 7300 yr BP, when the Waddinxveen channel belt had completed its avulsion, just upstream of Gouda (Figure 6; Cohen et al., 2012).

When the rate of relative sea-level rise decreased during the Atlanticum (at about 6000 yr BP; Figure 4C), the Waddinxveen system was able to prograde, while earlier channel belts gradually flooded due to the rapid sea-level rise (transgressive systems). The decrease in sea-level rice was caused by the completed melting of the ice caps on Scandinavia and North America, around 6000 yr BP (Stouthamer et al., 2015).

During the Atlanticum and successive Subboreal period, peat formation (further discussed in section 2.2.2) took place in the study area (Figure 4 C & D). The Waddinxveen channel belt was still active during part of the Subboreal, until a major upstream avulsion at Maurik took place (6600 yr BP; Cohen et al., 2012). This initiated a period with little fluvial influence.

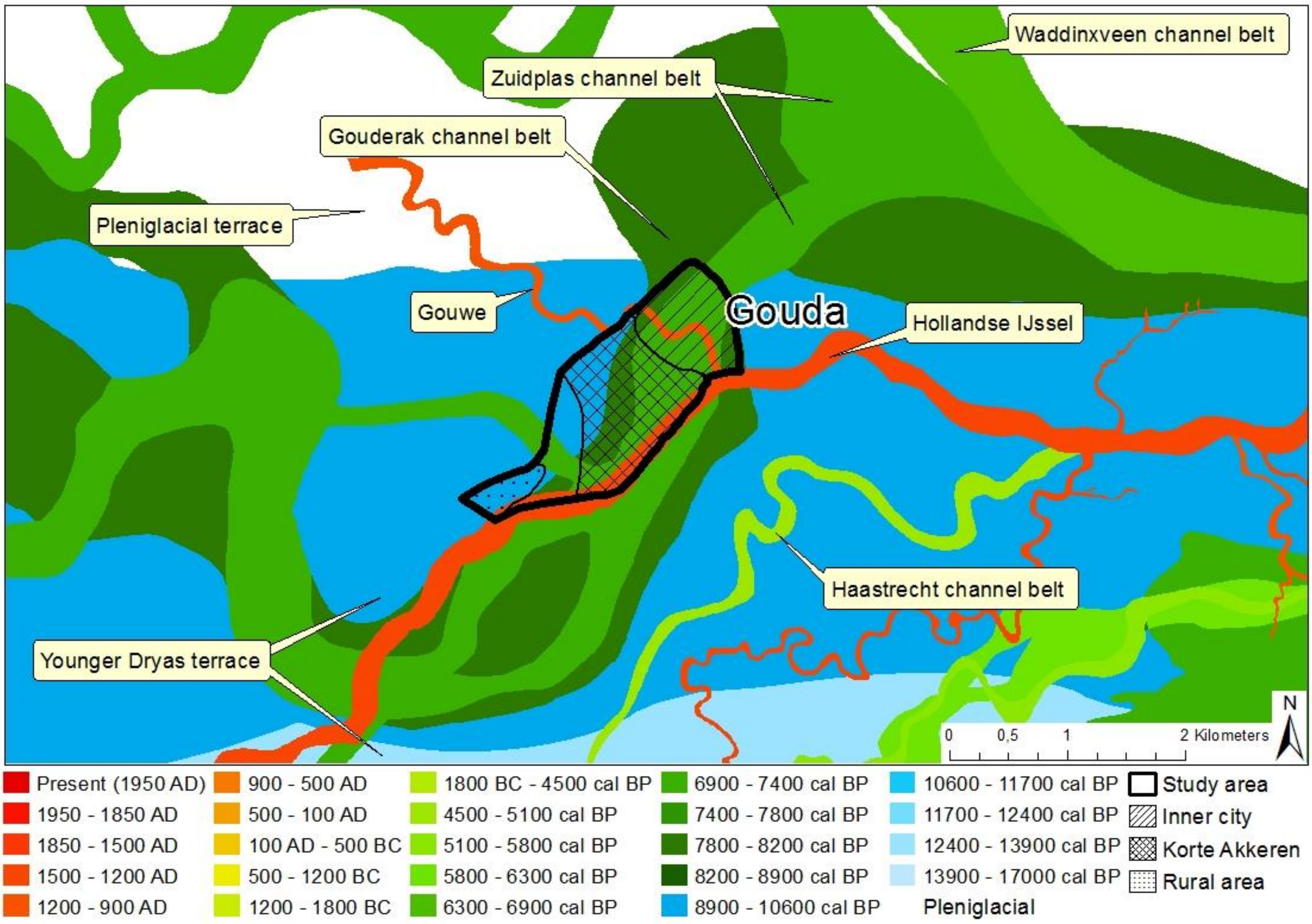


Figure 6 Course of the different channel belts, colors indicate the periods in which each channel was abandoned (after Cohen et al., 2012). Both the inner city of Gouda and the most important channel belts are indicated. Furthermore, the locations of the Pleniglacial and Younger Dryas terrace are also indicated. The extent of this image is indicated in Figure 1.

From approximately 5600 to 4300 yr BP the small Haastrecht channel belt (Figure 6) was active in the study area. Afterwards, fluvial influence was low again until the Hollandse IJssel (Figure 6) became active around 1700 yr BP. Figure 6 also indicates the channel of the Gouwe, which would have been active since 1700 yr BP (same as Hollandse IJssel; Cohen et al., 2012). However, (van Dasselaar et al., 2013) found a second residual channel of the Gouwe in the subsurface, known as the Oude-Gouwe (Figure 8)

2.2.2 Peat formation

Under normal conditions plant litter would decompose into H_2O and $C0_2$ under aerobe conditions or into CH_4 under anaerobe conditions. Therefore, peat can only form in regions where the accumulation of plant litter is faster than the decomposition. These are mainly areas with wet conditions and moderate temperatures. The wet conditions prevent aerobe decomposition (oxidation) of organic material. Furthermore, moderate temperatures enable the formation of organic matter by plant growth, but keep the decomposition rates low (both aerobe and anaerobe) (Stouthamer et al., 2015).

When river water stagnated in the floodplains after a river flood peat could start to form in the floodplain areas. Depending on the water depth, different kinds of peat were formed (Stouthamer et al., 2015). In deep stationary water (e.g. a lake) small organic particles could settle forming organic sediment called Gyttja. Subsequently, peat is formed form reed, sedge and trees in increasingly shallow waters. Eventually, peat can also be formed above the groundwater table, due to the local storage of rain water. The peat formed under such conditions is oligotrophic and made up by sphagnum (moss).

In the Rhine-Meuse Delta peat formation started during the Atlanticum (Figure 4C). The development of peat was enabled by the high groundwater levels during this period, providing the conditions for peat to form in the distal floodplains. The high groundwater levels were caused by the rising sea-level, which triggered the groundwater levels to rise as well, following the surface relief (Figure 7) (Stouthamer et al., 2015).

The decreased relative sea-level rise at the end of the Atlanticum (at about 6000 yr BP) enabled the formation of coastal dunes during the Subboreal (2600 to 5700 yr BP) (Figure 4D). This resulted in a decreased interaction between the sea and the rivers, causing the water in the upstream area to become less saline, which increased the peat formation. Additionally, the formation of the beach ridges also disabled erosion of peat by intrusions of the sea, during storms.

When the Waddinxveen channel belt (Figure 6) was completely abandoned (at about 6600 yr BP), a period of little fluvial influence had arrived. This, in combination with the coastal dune formation, enabled uninterrupted peat formation in the Gouda region.

During the period of peat formation, the minor Haastrecht channel belt was active in the Gouda region for a short period of time (5600 to 4300 yr BP; Figure 6). Peat formation would probably have continued in the period that the Haastrecht channel belt was active, as it was only a minor river, which generally transport little sediment.

However, at approximately the same time as the origin of the Hollandse IJssel, the sediment load and discharge of the Rhine and IJssel increased drastically. This increase was caused by deforestation of the hinterland since the Roman and Medieval times (Stouthamer et al., 2015). This resulted in an increased overbank deposition, causing the peat formation to cease and fluvial sediments (Echteld Formation) to be deposited over the peat (Nieuwkoop Formation) (Stouthamer et al., 2015; TNO, 2014).

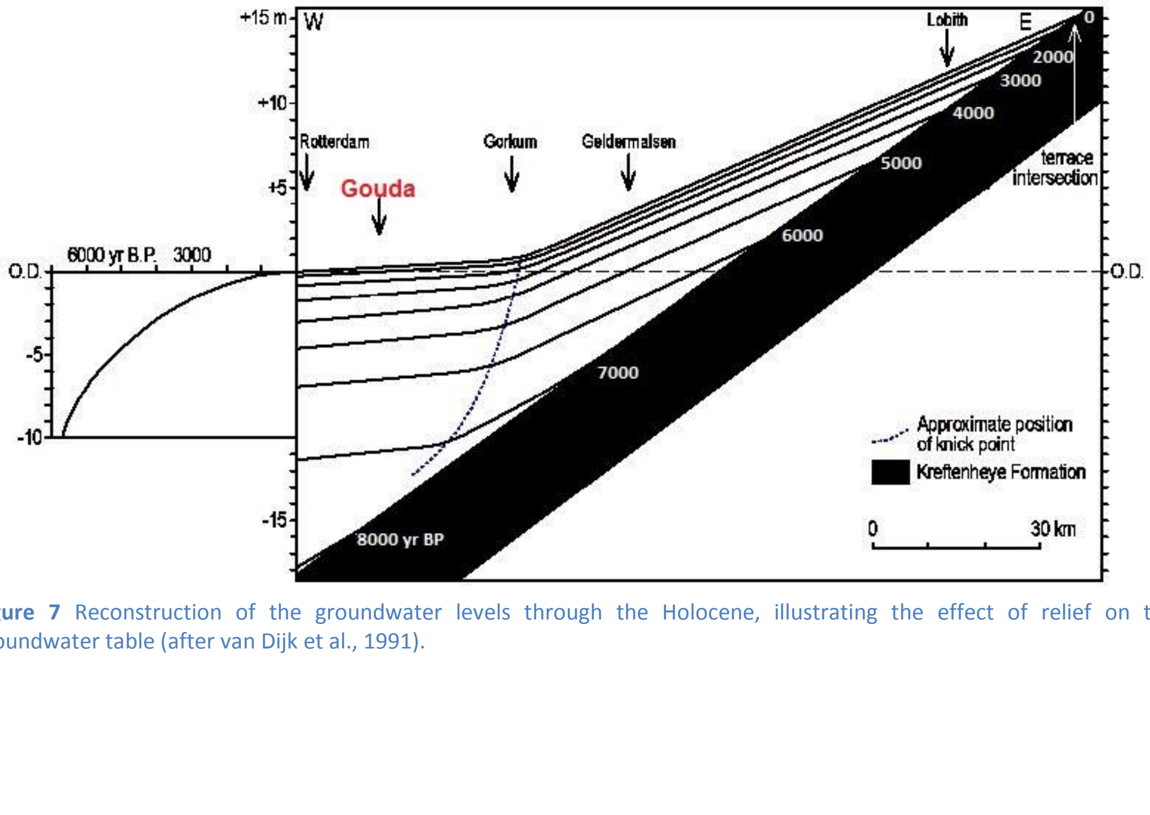


Figure 7 Reconstruction of the groundwater levels through the Holocene, illustrating the effect of relief on the groundwater table (after van Dijk et al., 1991).

2.2.3 Anthropogenic development

Before 1000 AD the floodplains in the western peat area were inhabitable wildernesses. However, due to population growth additional food and new settlements were needed and land reclamation of peat areas provided space for new cultivated areas (both agricultural and urban). The first settlements in the western peat area were located on the natural levees along rivers. Subsequently, the Cope-reclamation started (1000-1300 AD), using natural levees as reclamation base (Berendsen, 2008). Ditches were dug perpendicular to the reclamation base to drain excess water from the wet soils to a natural channel.

The lowering of the groundwater table, required for land reclamation, caused oxidation of peat which resulted in subsidence. To keep the land from flooding, additional drainage was then needed. However, the subsidence caused by groundwater table lowering was eventually compensated by anthropogenic raising of the land-level, as groundwater level lowering was no longer feasible.

The thickness of the anthropogenic layer varies throughout Gouda, depending on the underlying geology and the start of urbanization. Van Dasselaar et al. (2013) show that anthropogenic deposits are thickest above peat layers and thinnest over the residual channel deposits in the inner city (Figure 8), due to the difference in their relative sensitivity to subsidence.

Additionally, the added load due to ground level raising caused further subsidence, as the underlying peat consolidated under the added weight. In turn, this resulted in more anthropogenic deposition to maintain the land-level, causing a vicious circle. Therefore, the thickness of the anthropogenic layer in different areas also depends on the start of urbanization. Currently, the anthropogenic deposits in the inner city are locally more than 5 meters thick (Figure 8), while several cores outside the city show a thickness of only 1.5 meters (Figure 8; van Dasselaar et al., 2013).

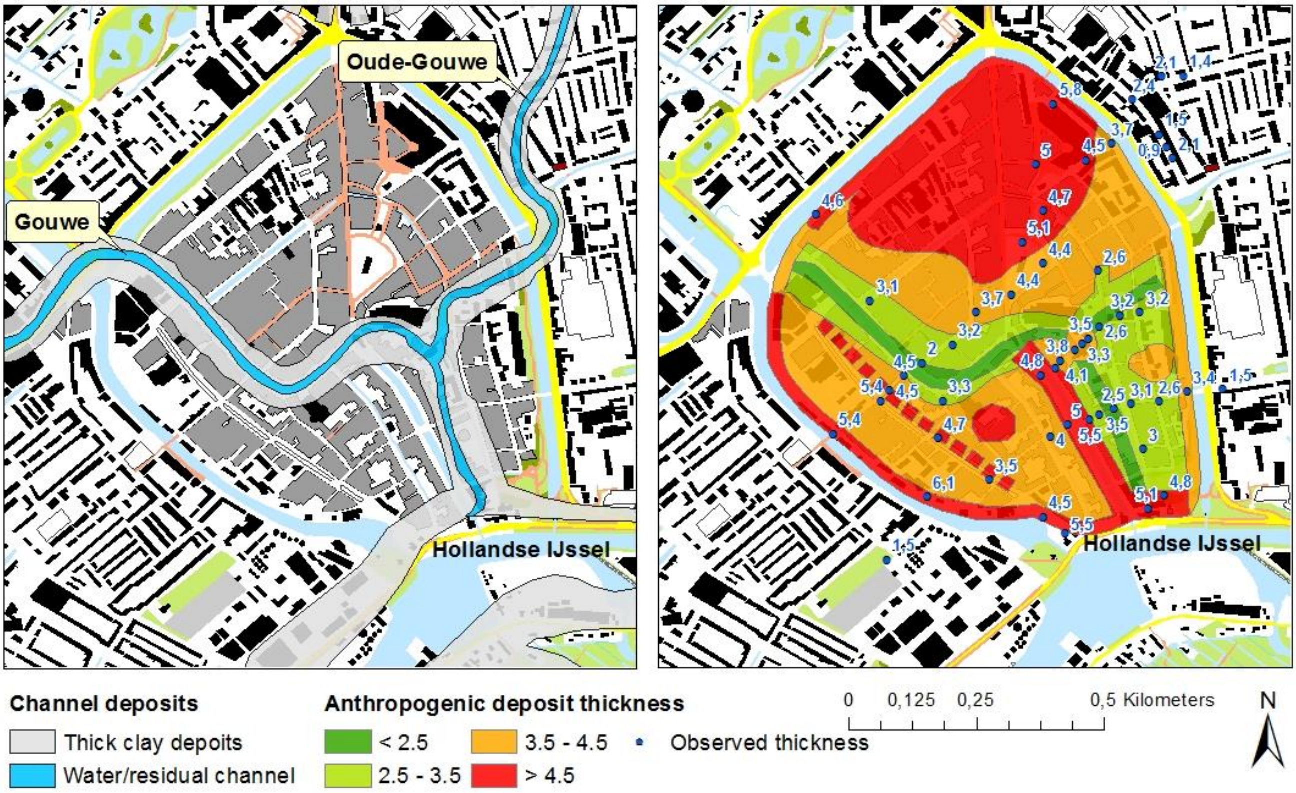


Figure 8 Course of the Gouwe and residual channel of the Oude-Gouwe (left). Thickness of the anthropogenic deposits (right) (after Van Dasselaar et al., 2013).

3 Mechanisms and drivers causing land subsidence

Land subsidence is generally caused by a combination of various mechanisms, which are driven or accelerated by certain external processes (drivers). Each of the mechanisms contribute in different amounts, depending on their sensitivity to certain natural or anthropogenic conditions and drivers (e.g. geology or water management). This results in spatial differences in the amount of subsidence; called differential subsidence. To understand which processes are responsible for the subsidence in Gouda, a good understanding of the different mechanisms and drivers is needed. Therefore, this chapter will discuss the different mechanisms known to cause subsidence (section 3.1), as well as the drivers known to influence them (section 3.2).

The four mechanisms behind land subsidence are: tectonics (η_t), isostasy (η_i), consolidation and compaction (η_c), and oxidation (η_o). These four mechanisms are influenced by five anthropogenic drivers: hydrocarbon fluid withdrawal (η_{hc}), groundwater extraction (η_{gw}), urban loading (η_{ul}), salinization (η_s), and surface water drainage (η_d). The subsidence caused by these different mechanisms and driver combined yields the observable subsidence signal (subsidence rates), which has to be unravelled to asses which processes are causing subsidence in a certain region.

The total subsidence signal (η) can be divided in a natural component (η_n) and an anthropogenic component (η_a) (equation 3.1). Equations 3.2 and 3.3 give the components making up both the natural mechanisms and the anthropogenic drivers accelerating the natural processes, respectively (after Tosi et al., 2009).:

$$\eta = \eta_n + \eta_a \tag{3.1}$$

where

$$\eta_n = \eta_t + \eta_i + \eta_c + \eta_o \tag{3.2}$$

and

$$\eta_a = \eta_{hc} + \eta_{gw} + \eta_{ul} + \eta_s + \eta_d \tag{3.3}$$

Figure 9 illustrates the relation between these different mechanisms and drivers. This shows that tectonics and isostasy are not affected by anthropogenic drivers, whereas consolidation and compaction, and oxidation are. Figure 9 also illustrates the depths at which the different processes act, relative to each other. In sections 3.1 and 3.2 the different processes are therefore discussed in order of their relative depth.

3.1 Subsidence mechanisms

3.1.1 Basin and local tectonics

Tectonic subsidence can be caused by basin tectonics or local tectonics. Basin tectonics act at a large scale and are caused by tectonic movement of entire sediment basins. The Netherlands are situated in the tilting North Sea Basin sediment basin, which formed during the Tertiary (Stouthamer et al., 2015) and is currently subsiding at a rate ranging from 0.01 to 0.06 mm/yr in the southeastern and northwestern part of the Netherlands, respectively (Figure 10A; Kooi et al., 1998). In the Gouda region, basin tectonics induce a subsidence rate of about 0.03 to 0.04 mm/yr (Figure 10A).

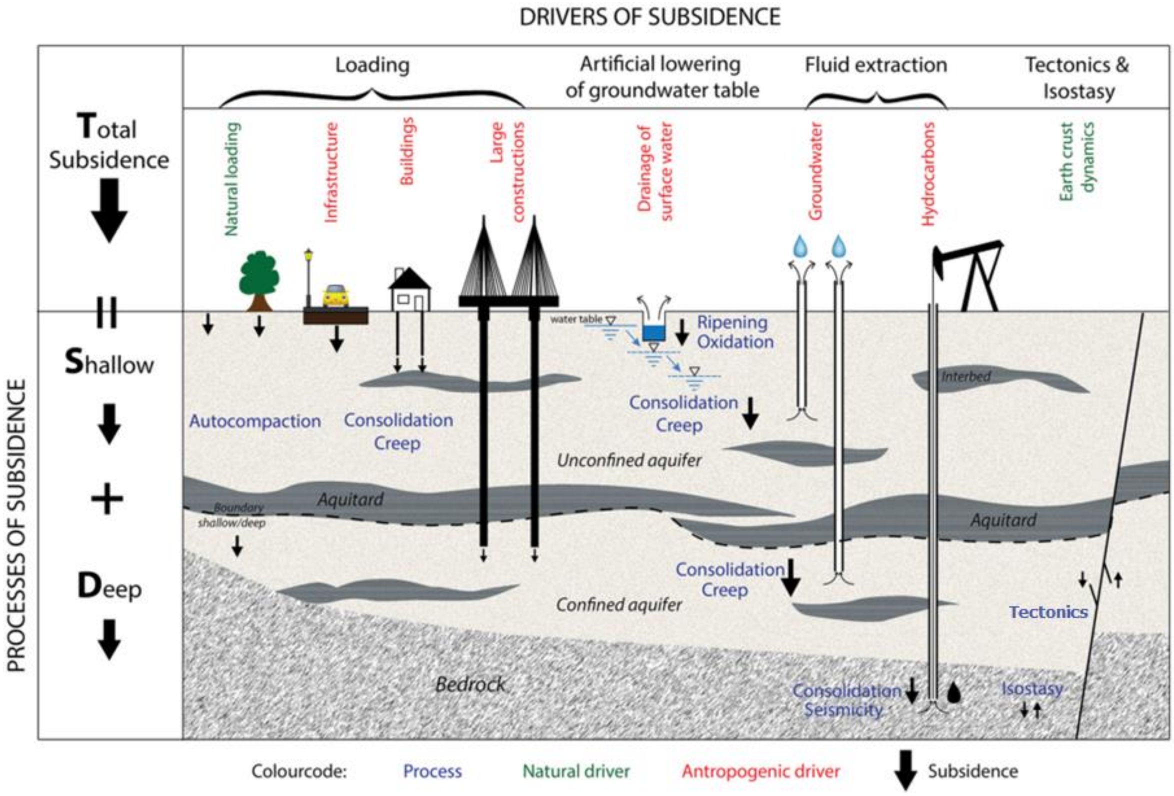


Figure 9 Illustration of the different mechanisms and drivers causing subsidence at different depths (Minderhoud et al., 2015).

Local tectonic are caused by the motion of two different tectonic blocks along fault. In case of subsidence, blocks move along a normal fault, which are formed by the rifting of continental plates, due to convection currents in the asthenosphere (Yuill, Lavoie, & Reed, 2009).

In the Netherlands only a couple of faults are active, which were formed during the early Tertiary (Stouthamer et al., 2015). These active faults have a northwest-southeast orientation and most are located at the Peel Boundary Fault-zone in the southeastern part of the Netherlands (Figure 10B). The subsidence caused by the tectonic activity along the Roer Valley Graben has an absolute rate of 0.03 to 0.07 mm/yr (Cohen, 2003).

Figure 10B illustrates that the main active faults are situated to the southeast of Gouda, indicating that Gouda would experience relatively little local tectonic subsidence. Therefore, the tectonic subsidence component near Gouda is mainly governed by tilting North Sea Basin. The contribution of the basin tectonics is, however, relatively small compared to the subsidence rates observed in Gouda (Chapter 2). The observed subsidence rates are in fact two to three orders of magnitude larger than the rates caused by basin tectonics.

3.1.2 Isostasy

Isostasy is the vertical movement of the surface caused by the flow of the liquid asthenosphere from an area that is loaded by ice (glacio-isostatics) or water (hydro-isostatics) to a less pressured area. This redistribution of the asthenosphere causes the area in front of the loaded region to be uplifted (forebulge area; Figure 11A). When the load is removed (e.g. due to melting ice sheets at the end of a glacial period) the forebulge will slowly collapse, causing subsidence (Figure 11B). This subsidence continues after the load is removed, as the high viscosity of the asthenosphere delays the uplift and subsidence of the loaded and forebulge area, respectively.

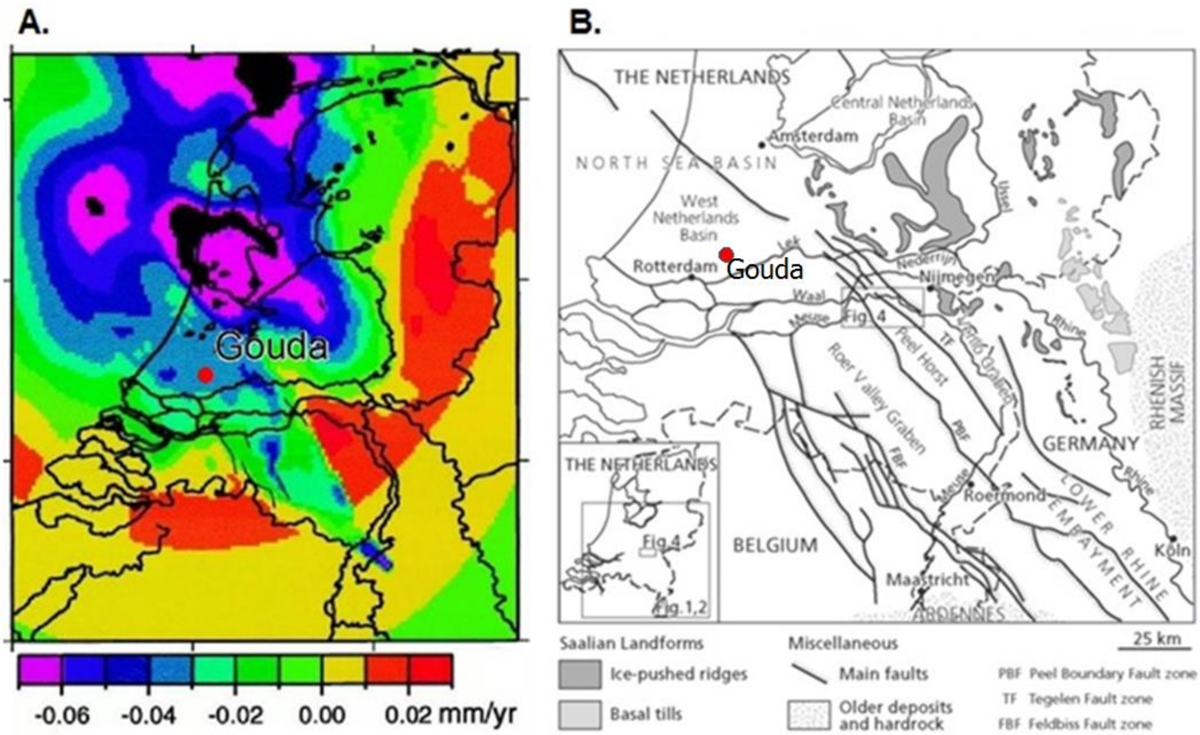


Figure 10 A) Map illustrating the subsidence rate (mm/yr) caused by basin tectonics during the Quaternary (Kooi et al., 1998). B) Map indicating the main faults present in the subsurface of the Netherlands. Currently only the PBF and FBF are active faults (Cohen, 2003).

Continued accumulation of sediments can also cause an increased weight upon the lithosphere (sediment loading). When this accumulation is fast enough, the lithosphere can be forced to bend, by forcing away the asthenosphere. Both sufficient sediment supply and sufficient accommodation space (e.g. valleys, lakes or deltas) are needed to realize sufficient sediment loading for subsidence to take place (Yuill et al., 2009).

To alter the distribution of the asthenosphere, a large pressure difference is needed. Therefore, changes in subsidence rates caused by isostasy only occur gradually over large distances (Figure 12B).

During the last glacial period (Weichselien), a maximum forebulge uplift was situated in the northern Netherlands (Figure 12A). So, when the ice sheet melted, the land-level in the Netherlands started to subside. As the glacio-isostatic uplift was highest in the north, the highest subsidence rates were also situated in the north of the Netherlands.

Additionally, the melt water collected in the North Sea (sea-level rise), as well as rapid sediment deposition (prograding delta) increased the load on the lithosphere. This caused the North Sea Basin to subside even faster than the southern region (Cohen, 2003). For Gouda the combined subsidence rate caused by sediment loading, glacio- and hydro-isostatics is about 0.1 mm/yr, for the last century (Figure 12B; Kooi et al., 1998). This rate is one to two orders of magnitude smaller that the observed subsidence rates in Gouda (Chapter 2). This indicates that isostatic subsidence is only contributing a small fraction to the total subsidence signal. Additionally, the low spatial variability in subsidence induced by isostasy does not correlate well with the high spatial variability observed in Gouda (Figure 2).

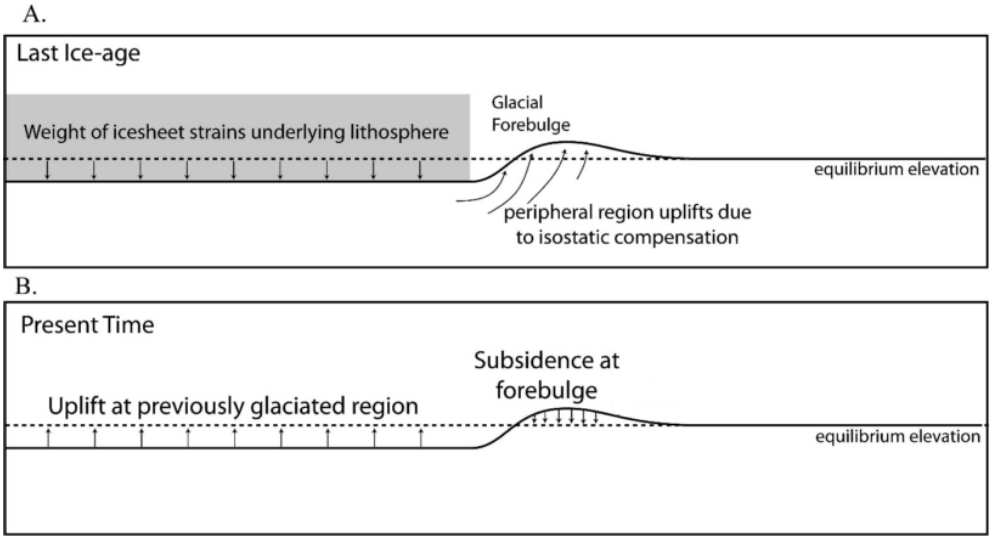


Figure 11 Schematic representation of glacio-isostasy. A) The formation of a forebulge area due to glacial loading. B) Forebulge collapse due to ice sheet melting (after Yuill et al., 2009).

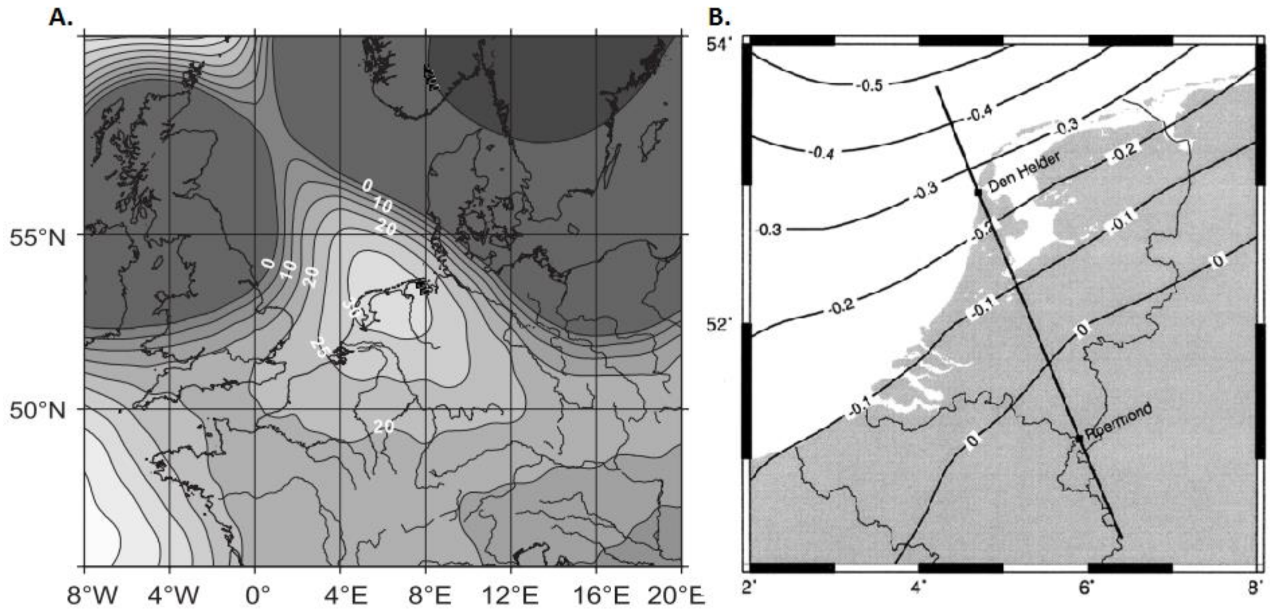


Figure 12 A) Predicted forebulge elevations (m) at 21 ka, given as elevation compared to present topography (Busschers et al., 2007). B) Modeled contour lines indicating the current subsidence rates (mm/yr), caused by isostatics movement over the last century (Kooi et al., 1998).

3.1.3 Consolidation and compaction

In geology, the terms consolidation, compaction and compression are used interchangeably. Though, there is a slight difference between consolidation and compaction, based on the medium that is forced from the soil pores. Compaction is defined as the loss of pore volume due to the instantaneous expulsion of air from pores, due to overburden pressure (Higgins, 2016). Therefore, compaction does not occur below the phreatic surface, as the soil is completely saturated. Consolidation describes the more gradual expulsion of pore water due to overburden pressure, and is dependent on the permeability of the deposit (van Asselen et al., 2009). When enough water expulsed from the sediment (primary consolidation) soil particles might also start to rearrange (secondary consolidation) due to the overburden pressure (Figure 13). Lastly, compression can be used as a collective term for both consolidation and compaction, as it describes the effect of both mechanisms, which is: the loss of pore space due to overburden pressure.

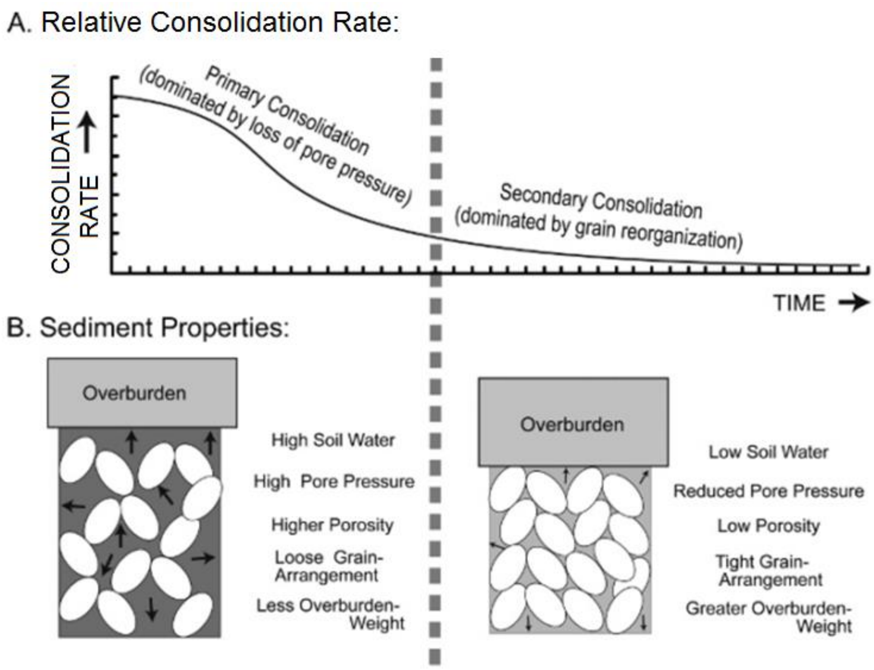


Figure 13 Plot of A) the relative consolidation rates and B) sediment properties of delta sediments in time (after Yuill et al., 2009).

Primary consolidation is caused by decreased hydrological pressure within the pores, related to the overburden and the permeability of the soil. When the pore pressure is lower than the stress executed by the overburden, the pores will fail, which results in a loss of soil volume (Yuill et al., 2009). For fine-grained deposits (e.g. clay) the time needed to reach a new equilibrium between pore pressure and overburden pressure may take longer, as their low permeability hinders the expulsion of pore water (Van Asselen et al., 2009).

Secondary consolidation is dominated by the reorganization of soil particles into a tightly arranged structure. Secondary consolidation takes place under high stress, as a new equilibrium between pore pressure and overburden pressure cannot be reached by expulsion of pore water alone (Yuill et al., 2009). Eventually, equilibrium is reached, due to the tight grain arrangement, which can withstand the overburden stress.

The amount and rate of consolidation is governed by the overburden pressure and a layer thickness and compressibility. The compressibility of a deposit is in turn dependent on the lithology, consolidation history, the resulting soil properties (e.g. porosity, permeability, organic matter content and density) and the pore water pressure (van Asselen et al., 2009). For instance, Figure 13A illustrates that the longer a deposit is loaded, the slower the consolidation process will proceed. This is caused by the decrease in permeability, as the pores become smaller and the expulsion of water becomes more difficult. Consequently, young Holocene sediments are more sensitive to subsidence, due to their relatively short compression history, while older deposits are less compressible due to earlier volume loss (Tosi et al., 2009; Van Asselen, 2010)(Figure 13A).

Variations in subsurface architecture can cause differential consolidation and compaction rates, due to differences in overburden acting on compressible layers (thickness of the overlaying layers) and differences in the compressibility of lithological classes. Generally, small grained and organic sediments are more compressible than coarse grained layers (Yuill et al., 2009). Sand and gravel are nearly incompressible (Widodo & Ibrahim, 2012), whereas clay is rather compressible (Higgins, 2016). Peat has an even higher compressibility (Higgins, 2016), which is mainly governed by organic matter content and to a lesser extent to the plant species making up the peat (van Asselen et al., 2010). However, peat that has been subjected to earlier decomposition (e.g. by oxidation) compresses less under the same conditions than non-decomposed peat (Tokar & Solomonov, 1972).

All in all, non-uniform spatial distribution of different compressible and uncompressible lithologies causes differential subsidence. This is especially true for a prograding delta sequence (e.g. Rhine-Meuse Delta), as the subsurface architecture in such a sequence is far from uniform due to the large amount of past avulsions.

3.1.4 Oxidation

Plant litter preserved in peat (due to the deposition under anoxic conditions) makes peat sensitive to subsidence caused by oxidation. When peat becomes aerated, due to a lowered groundwater level, oxidation will cause a decrease in soil volume due to the decomposition of the preserved organic matter into CO_2 (Brouns, 2016; Tosi et al., 2009). Initially, the loss in peat volume results in an increased porosity. The higher porosity is compensated for by compaction under peat's own weight or the weight of overlying layers (Yuill et al., 2009).

In present rural and urban areas of the Rhine-Meuse Delta, a decrease in groundwater level can be caused by both natural and anthropogenic processes. Natural lowering of the groundwater table can, for instance, occur in summer due to high evaporation rates (Brouns, 2016). Furthermore, anthropogenic surface water drainage (section 3.2.5) from polder areas can increase the effect of oxidation.

Spatial differences in the thickness and composition of the deposits overlying a peat layer result in differential subsidence. If such a layer is composed of clay, oxygen will be hindered in entering the subsurface, and less oxidation can take place (Brouns et al., 2014). Furthermore, the thicker the overlying layer, the less peat lies within the unsaturated zone, and less organic matter can be oxidized. However, a thicker cover does increase the overburden, yielding more subsidence due to consolidation.

The amount of organic material present in a peat layer determines the maximum achievable amount of oxidation. Differences in organic matter content can be caused by an earlier stage of oxidation, but also by differences in deposition environment. Deposits in an area proximal to a river will have a higher clastic component, while distal deposits have a higher organic component (Stouthamer et al., 2015), enabling more oxidation.

Peat can also be decomposed by anaerobic processes. However, anoxic decomposition of peat is much slower than aerobic decomposition (Brouns, 2016). For instance, the annually mass loss (relative to the original mass) of the peat due to both oxic and anoxic decomposition differs an order of magnitude: 5 to 7 wt% yr^{-1} and 0.1 to 0.3 wt% yr^{-1}, respectively (Scanlon & Moore, 2000). Therefore, anoxic decomposition is neglected in this study.

3.2 Drivers of subsidence

3.2.1 Hydrocarbon fluid withdrawal

The withdrawal of hydrocarbons from the subsurface causes a loss of pore pressure within a reservoir. The loss of pore pressure causes a relative increase in the weight (effective stress) exerted on the sediment particles. This increased weight is normally counteracted by the hydrostatic pressure in the pores (buoyancy), but due to the decrease in pressure it is transferred to de soil matrix (Terzaghi, 1943; Yuill et al., 2009). Consequently, the reservoir starts consolidating and tectonic faults may form.

In the Netherlands, hydrocarbons (mainly natural gas) are only extracted in the northeastern part of the Netherlands and at the North Sea. The northern province of Groningen is the main area dealing with substantial subsidence at a rate of 0.5 to 5 mm/yr (NAM, 2013; Putten et al., 2016) caused by the extraction of natural gas. However, for Gouda no subsidence is caused by hydrocarbon extraction, as none is present in the subsurface.

3.2.2 Groundwater extraction

Groundwater extraction is often the largest contributing mechanism to the total amount of subsidence (e.g. Mekong Delta and Jakarta; Higgins, 2016). The extraction of groundwater for drinking water or irrigation purposes can cause overdraft of the groundwater reservoirs (aquifers), resulting in substantial subsidence due to decreased pore pressure (Yuill et al., 2009).

Groundwater is generally extracted from sandy aquifers that have a low compressibility index (Widodo & Ibrahim, 2012). However, the extraction from sandy aquifers often results in fast subsidence. This is because the aquifers are partly recharged by groundwater stored in clay layers (aquitards). This causes the compressible clay layers to be depressurized, which leads to reorganization of the loose and chaotically arranged clay particles into a dense and orderly structure. This loss in clay volume drives most of the subsidence caused by groundwater extraction (Isotton et al., 2015).

For Gouda, groundwater extraction is assumed to contribute very little to the total amount of subsidence. Stations where groundwater is extracted for drinking water are not located near the city of Gouda (Oasen, 2017). Other points were groundwater is structurally extracted are not found for the region, so groundwater extraction and the associated subsidence near Gouda are probably low.

3.2.3 Salinization

Salinization of the groundwater influences the speed at with which both clay and peat layers consolidate. In clay rich soils the ion concentration can act as a driver for subsidence. Clay particles are bound by an electrochemical force, but when the ion concentration increases, this force decreases and the clay mineralogy changes, causing the porous medium to become less stable. This decreased stability yields a reorientation of clay particles due to the weight of overlaying sediments, which leads to land subsidence (Tosi et al., 2009).

The effect of salinization on peat oxidation is completely opposite to the effect of salt concentration on consolidation of clay. Whereas high salt concentrations increase the compressibility of clays, the decomposition of peat decreases with increased salinity. Brouns (2016) found that aerobe decomposition can decrease with approximately 50% due to salinization.

Groundwater salinization can be induced by upstream migration of salt water due to tidal flow in rivers, of by seepage of saline groundwater from lower aquifers, which can be increased by anthropogenic groundwater extraction. Gouda is situated relatively far upstream, causing little to no salinization caused by tidal processes (Vellinga et al., 2014). The upward seepage of groundwater does not cause salinization either, as saline groundwater is situated 50 to 100 meters below NAP (Figure 14; de Louw et al., 2010; Oude Essink et al., 2010).

In coastal regions groundwater extraction can attract saline water from the sea, causing salinization of the aquifer and surrounding aquitards. As a consequence, subsidence within the clayey aquitards will be promoted. However, both the location of Gouda and the lack of groundwater pumping (section 3.2.2) will not promote salinization.

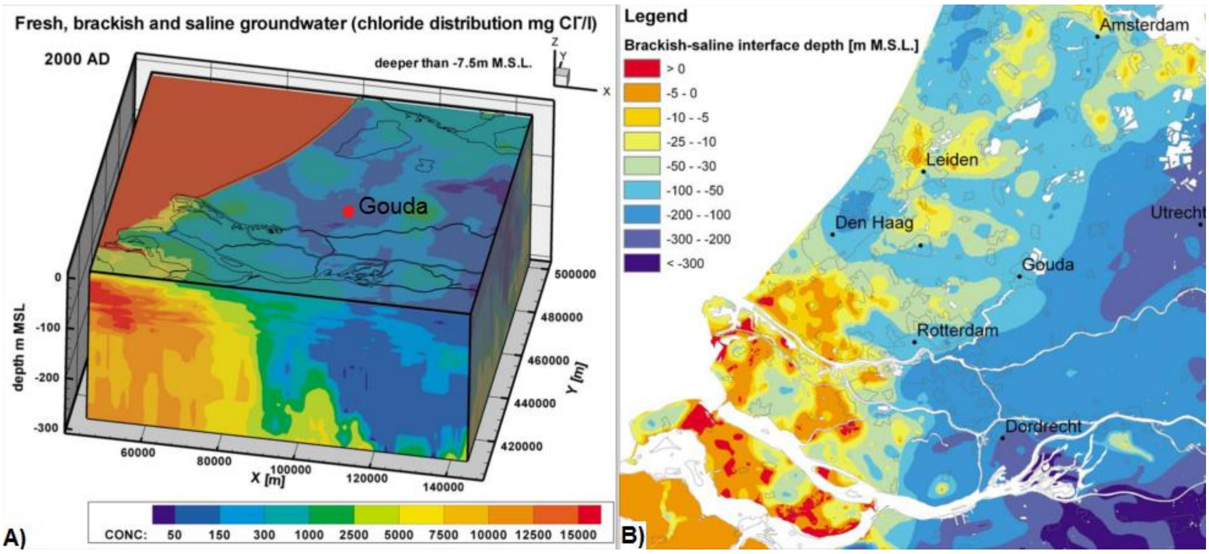


Figure 14 A) Interpolated chloride distribution of groundwater. B) Brackish-saline interface depth. (Oude Essink et al., 2010)

3.2.4 Urban loading

Natural consolidation of young deposits can be accelerated by the construction of buildings and infrastructure, which add an additional load to the surface (Terzaghi, 1943; Tosi et al., 2009). This increased load results in an additional effective stress to be exerted to the underlying layers, causing them to compact and consolidate.

Traditionally, buildings and cities were built on elevated locations to optimize flood safety. These higher areas were often the result of the local presence of relatively incompressible deposits, while the soft deposits in the surrounding areas had slowly subsided over the years (Berendsen, 2008). However, due to population growth and better flood security low laying areas with soft soil and larger subsidence potential were cultivated to provide sufficient space for urban expansion.

Generally, the effect of urban loading on soft soils depends on the thickness of both anthropogenic and underlying soft deposits, the weight of constructions and the type of foundation used to support a structure. Heavier constructions and thicker anthropogenic deposits exercise a larger pressure, causing faster subsidence in urban regions. Moreover, the type of foundation used for a building determines largely at which lithological layer the load of the construction is applied. The main foundation types used for the buildings in Gouda are: spread footing, friction piles and end-bearing piles (van Winsen et al., 2015). Spread footing foundation spreads the pressure of a load-bearing wall over a larger area of the upper soil, causing more stability. Friction piles foundation distributes the load of a building over piles which are founded within a relatively soft layer. In this case the friction between the piles and the soil generates stability for a construction. End-bearing piles are founded on a strong soil layer (e.g. sand) below the weaker overlaying soil (e.g. peat), causing great stability.

Figure 15 illustrates the differences in stability between structures founded on spread footing and end-bearing piles. Spread footing foundations subside at the same rate as the compressible deposits on which it is founded, while structures founded on end-bearing piles remain elevated. Figure 15 also illustrated that groundwater levels are lowered to compensate for flooding of buildings founded on spread footing. A lot of houses in Gouda are, however, founded on wooden end-bearing piles, which are negatively affected by groundwater lowering. When the wood falls dry, the piles start to rot, causing structural damage to these houses.

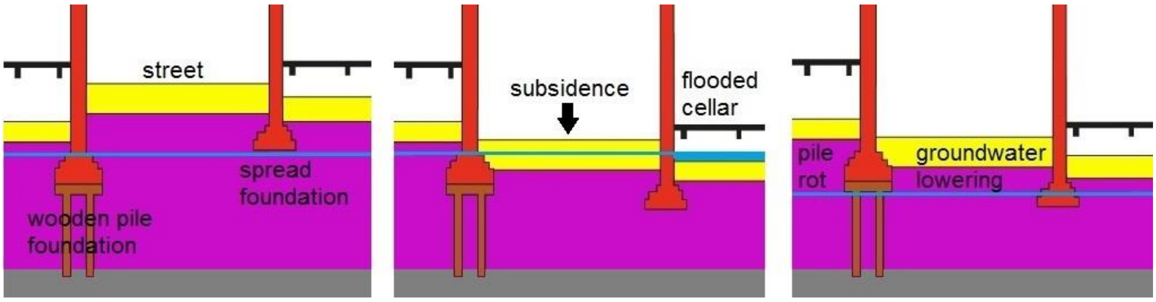


Figure 15 Illustration of the effects of subsidence on buildings founded on wooden piles and spread footing foundations (indicated in left figure). Red indicates the walls and top of the foundation, black = floor level, brown = wooden piles, yellow = anthropogenic deposits, violet = peat, grey = solid sandy deposits and the blue line indicates the groundwater level. Middle figure: through time, peat is compressed due to loading, causing the street and spread footing founded house to subside and the cellar of this house to flood. Right figure: groundwater is lowered to keep the cellar of the spread footing founded house dry, which additionally causes the wooden piles to rot.

All in all, urban loading results in a differential subsidence signal due to differences in subsurface build-up, construction weight and foundation types. A differential subsidence pattern is observed in Gouda as well (Figure 2), which can be explained by urban loading, as the city is mainly build on a soft peat soil and foundation types vary widely throughout the city (Royal HaskoningDHV, 2015).

3.2.5 Surface water drainage

In cultivated peat areas, surface water has to be drained to keep the land dry. Groundwater tables are humanly controlled in these areas, by digging ditches or canals. A lower water level is maintained in these ditches, triggering the groundwater from the adjacent land to flow to these ditches, causing the wet peatlands to be drained.

Surface water drainage in cultivated areas results in accelerated subsidence due to amplified loading and oxidation. First of all, lowering the groundwater table decreases the pore pressure causing a raise in effective stress throughout the entire sediment column (Terzaghi, 1943; Yuill et al., 2009). The relative increase in effective stress decreases with depth, as at larger depths the added weight is relatively small compared to the weight of the entire sediment column. Therefore, the increase in effective stress due to surface water drainages mainly causes volume loss in the shallow compressible deposits.

Secondly, lowering of the groundwater table in peat rich regions can result aeration of peat, causing oxidation (Figure 16). In order for a peat layer to become aerated, either the peat has to be situated close to the surface, or groundwater levels should be significantly lowered.

Subsidence caused by the effect of added load due to surface water drainage occurs in both areas with and without peat, whereas oxidation only occurs in regions here peat is situated close to the surface. Consequently, in an area where peat is situated just below the surface, groundwater table lowering causes both oxidation and increased loading.

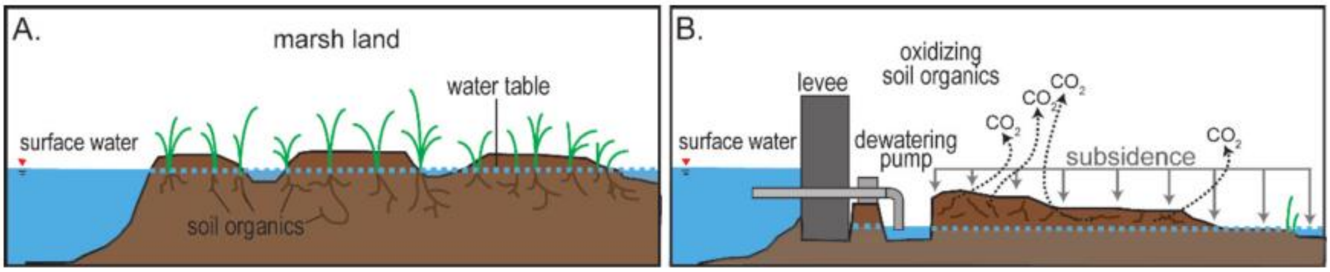


Figure 16 A) Natural marsh land, which is drained for land reclamation purposes. B) Same marsh land after anthropogenic drainage and associated groundwater table lowering, which resulted in oxidation based subsidence. Adopted from Yuill et al. (2009).

3.3 Concluding remarks

Based on the literature discussion above, it can be concludes that consolidation (related to the urban loading) and possibly oxidation of the peat layer underneath Gouda are the main mechanisms causing the observed subsidence in Gouda. Tectonics and isostasy do contribute to subsidence as well, but their contribution is respectively two to three and one to two orders of magnitude smaller than the observed subsidence rates, making them relatively unimportant on a short timescale.

The main effects driving subsidence in the city of Gouda are urban loading and possibly surface water drainage. Urban loading by both constructions and the anthropogenic deposits (used to raise the land) accelerates the consolidation of the peat layer due to an increase in effective stress. The amount and rate of subsidence caused by this process are mainly governed by the overburden and the compressibility and thickened of the peat layer.

In the past surface water drainage caused both increased effective stress and oxidation of the peat layer, which leaded to the initial subsidence of the area. However, based on literature it is impossible to determine if groundwater lowering still plays a significant role in the subsidence of Gouda. The effect of added effective stress can probably be neglected as its increase will be relatively small compared to the total urban loading. However, oxidation might still contribute to the total subsidence. If the peat layer underneath Gouda is aerated either the whole year round or periodically (due to dry periods) oxidation of the peat's organic matter will cause subsidence.

Subsidence driven by salinization and fluid extraction can be ignored based in the literature, as Gouda is located relatively far inland and neither hydrocarbons nor water is extracted from the subsurface near Gouda.

Both of the main mechanisms left (consolidation due to urban loading and oxidation) to account for the subsidence in Gouda depend greatly on the subsurface architecture. To predict consolidation, the spatial distribution of the compressible layer and the overburden are the most important characteristic of the subsurface build-up. However, to assess the contribution of oxidation the depth of the peat layer and the phreatic surface are most important. Consequently, both a detailed representation of the subsurface architecture and knowledge on the peat compressibility and organic matter content are needed in order to assess the subsidence potential of the different parts of Gouda.

4 Methods

To find the mechanisms governing subsidence in the city of Gouda and to assess the subsidence potential of the city, knowledge on both the subsurface architecture and the sensitivity of the peat layer to the subsidence mechanisms was required. The first main step was to find the responsible mechanisms, as the presences behind subsidence influence the way the subsidence potential has to be determined. Chapter 3 already concluded that consolidation due to urban loading and oxidation are the most likely main mechanisms. The question that remains is whether oxidation can occur within the peat layer, which is covered by anthropogenic deposits. To assess the probability of oxidation a 3D representation of the subsurface was required to assess whether the peat layer could get aerated.

The construction of a 3D lithostratigraphic model of the subsurface build-up required a sufficient amount of lithological data. Consequently, lithological core descriptions from an existing archeological study were obtained and additional cores were acquired during a field campaign (section 4.1.1). Using this data, the 3D subsurface model was build (section 4.3.1), enabling the further unraveling of the subsidence signal (section 4.3.2).

In the second main step, the subsidence potential of the city of Gouda was estimated. To generate an indication of the subsidence potential, knowledge on the current degree consolidation of the peat was needed. In order to acquire the current degree of consolidation, peat was sampled at four locations (section 4.1.2) and tested for their dry bulk density and organic matter content (section 4.2.1), which were used to compute the peat's degree of consolidation (section 4.2.2). Based on the current condition of the peat, the subsidence potential could be assessed (section 0).

The description of the methods is subdivided in 3 main sections to structure this chapter based on the general order in which the different methods were performed. The first section (section 4.1) discusses the field data collection of both core descriptions and peat samples. This section is followed by the description of the laboratory methods (section 4.2) and the data processing needed to unravel the subsidence signal and to assess the subsidence potential (section 4.3).

4.1 Field methods

4.1.1 Lithological core collection

The lithological data used for the construction of the 3D subsurface model was partly obtained from an existing archeological study by Van Dasselaar et al. (2013), which included 57 lithological core descriptions. Still, additional cores had to be logged, as the archeological data set primarily covers the inner city and several parts of the inner city had low data coverage.

The archeological data set shows lower data concentrations in the north-northwestern part, as well as the most western and eastern part of the inner city (Figure 17). Only one of the cores described by Van Dasselaar et al. (2013) was located within Korte Akkeren. Many new cores would be needed to achieve the same data density in Korte Akkeren as in the inner city. However, the expected spatial variability in lithological subsurface build-up is assumed to be higher in the inner city than in Korte Akkeren. This assumption is made because the differential subsidence in the inner city (caused by differences in initial subsurface build-up and foundation types) has been taking place for a longer period of time. The long differential subsidence of the inner city would, therefore, have resulted in a larger spatial difference in subsurface build-up than in Korte Akkeren. Consequently, a lower data density for Korte Akkeren is deemed sufficient.

The lithological data was manually acquired, using Edelman and gouge augers (Eijkelkamp, 2012). At some locations a Van der Staay suction corer (Van de Meene et al., 1979) was used to get though the sandy top layer. In these cases, an additional PVC casing was pushed into the ground, to keep the hole from filling with sand. Each core was logged at intervals of 10 cm, describing the sediment using the NEN-classification (Bosch, 2000). For each 10 cm interval the following properties were determined and systematically documented (Appendix 6): the soil texture (Figure 18), organic matter (Figure 18), color, plant remains, chalk content, anthropogenic admixture and other relevant properties.

Core locations

Thirteen new core descriptions were gathered to cover Korte Akkeren (7 cores) and the rural (1 core) area, and to fill the low data density areas in the inner city (5 cores) (Figure 17). The core locations were chosen based on two criteria: 1) the locations had to be relatively easy to core (e.g. bare soil surrounding a tree, a wide sidewalk or a grass strip) and 2) the cores had to be located near one of two perpendicular cross-sections that run though the inner city and Korte Akkeren (cross-sections E2 and F; Figure 17).

The two cross-sections were designed through Korte Akkeren, the inner city and the rural area, as this research compares the current condition of the subsurface between these districts. The cross-sections where constructed in such a way that the first runs through the eastern and western low data density zone of the inner city, as well as through Korte Akkeren and the rural area (Cross-section E2: an expansion of cross-section E-E'; Appendix 4) (Figure 17). The second cross-section is designed to include the northern low data density area of the inner city, as well as the northern part of Korte Akkeren (Cross-section F; Figure 17). A third cross-section through the inner city was added perpendicular to the other two cross-sections and the Hollandse IJssel, crossing the northern low data zone (Cross-section A2; based on cross-section A-A'; Appendix 4) (Figure 17). Section 4.3.1 describes how these cross-sections were, subsequently, interpreted to gather insight in the subsurface build-up and how they were used to construct the 3D lithostratigraphic subsurface model.

The aim of each core was to reach the base of the peat layer and if possible the top of the Pleistocene sands. For most cores, the base of the peat layer was reached, but for three cores (B004, B005A and B0012) this was impossible. Moreover, core B005A did not reach peat at all, as it came across a hard object in the anthropogenic top layer at 2.5 m below surface elevation, therefore a second core (B005B) was logged near this location (50 m to the northwest). The Pleistocene sands were not reached, but the Wijchen Member was reached at cores B006 and B012. All in all, most cores reached a depth of about 7 to 11 meters below surface level.

4.1.2 Peat sampling

To assess the current degree of consolidation of the peat layer at four different locations, the peat at each location had to be sampled. After cross-section interpretation, which enhanced the understanding of the paleogeographic development of the region, a second field campaign was arranged. During this campaign the peat layer at the four locations was sampled over its complete depth interval. Sampling was conducted manually, using a 6 cm (inner diameter) wide and 1 m long gauge, to ensure as little as possible disturbance of the samples. As only the peat was sampled, the boreholes had to be prepared before sampling, by coring though the anthropogenic layer, using an Edelman auger.

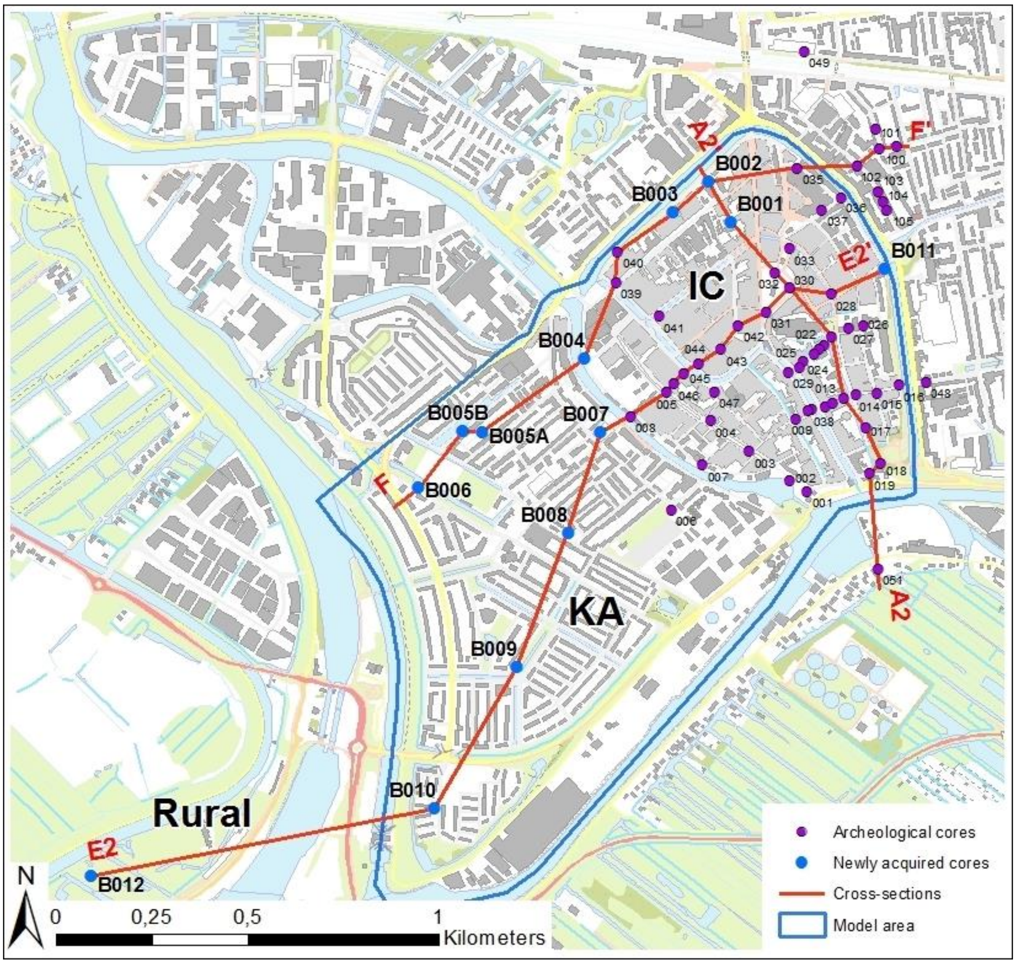


Figure 17 Map indicating the cores locations from the archeological study by Van Dasselaar et al. (2013) (also given in Appendix 4), the newly acquired core locations, the constructed cross-sections and the area within which the subsurface was 3D modeled. Additionally, the three sub regions of the research area are indicated: IC=inner city, KA=Korte Akkeren and Rural=rural area.

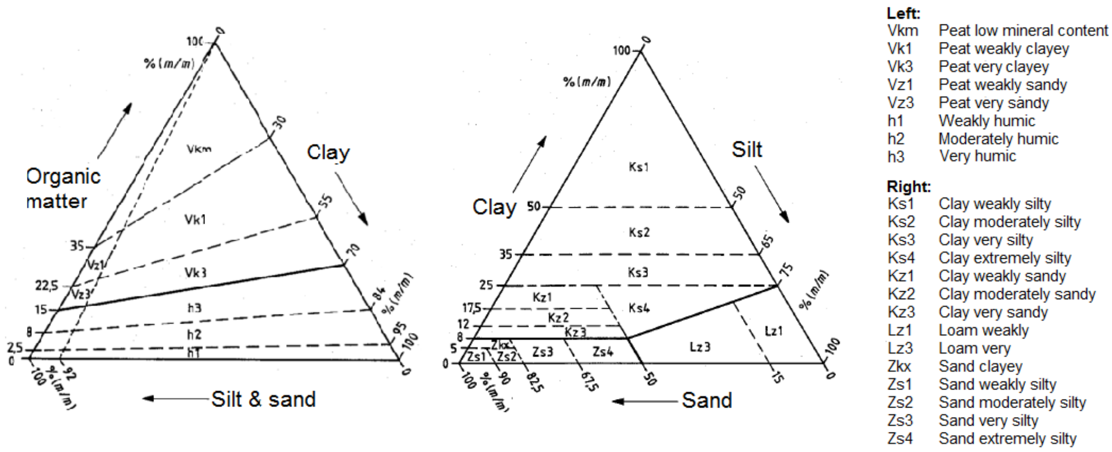


Figure 18 Texture triangles for peat (left) and clastic sediments (right), indicating the mineral composition of each deposit and peat type as a percentage of the total volume (after Bosch, 2000).

The samples were sealed using plastic foil to prevent oxidation. Subsequently, the samples were placed in-between two bisected PVC-pipes to ensure stability during transport and storage. Finally, the PVC-pipes were sealed a second time to minimize the oxygen supply to the samples. Thereafter, they were transported to Utrecht University, where they were placed in a cooled storage unit to minimize decomposition processes.

Core locations

The four sampled core locations were selected based on two main criteria. First of all, each location had to currently undergo a different stage of consolidation than the other selected locations. Therefore, locations were selected which have been experiencing urban loading for different time spans. This resulted in the selection of 4 locations decided over 3 regions (sorted from longest to shortest loading period): one in the inner city, one in the eastern part of Korte Akkeren, one in the middle of Korte Akkeren and one in the rural area (reference site; no urban loading).

Secondly, preparing the boreholes and gathering of peat samples at large depths (up to 10 meters below surface elevation) with a 6 cm wide gauge is physically heavy work. Locations were, therefore, chosen based on their relatively low archeological admixture content in the anthropogenic layer and their relatively thin anthropogenic layer. The low amount of archeological admixture and a thin anthropogenic layer ensure easier borehole preparation, increasing the change on a successful sampling site.

Based on these two criteria, samples were collected at core locations B002, B007, B009 and B012 (Figure 17). The amount and the duration of loading decreased over these locations; from high in the inner city to low in the rural area. For the two cores in Korte Akkeren, the first (B007) is situated on a parking lot which was a former building block. The second Korte Akkeren core is located in a strip of grass (without any extreme former history of constructions) alongside a small canal.

Despite careful site selection, complete sampling of the inner city core (B002) with the 6 cm gauge proved impossible, due to the dense peat at large depth. Therefore, a switch was made to a 4 cm wide gauge at 8.2 m below surface level.

4.2 Laboratory methods

4.2.1 Testing of dry bulk density and organic matter content

To assess the current degree of consolidation of the peat underneath Gouda a series of empirical relations were used (section 4.2.2). These relations are based on dry bulk density (ρ_{dry}) and organic matter content (LOI) of a peat sample (Van Asselen, 2011). Therefore, ρ_{dry} and LOI had to be measured for each of the four sampled cores.

To acquire this data, the peat samples were cut in half (lengthwise), so that the inner, least disturbed, peat could be sampled. Sampling was done continuously every 5 cm, using a sampler of 5x1x1 cm in longitudinal direction. Then each sample was weighted on an electronic scale (precision of 0.001 gr) and dried at a temperature of 105°C for 24 hours. Afterwards the samples were weighted again to calculate the dry bulk density of each 5 cm^3 sample (ρ_{dry} = dried weight/5cm^3) (Appendix 10). The estimated error for the ρ_{dry} determination is assumed to be equal to the error estimated by Van Asselen (2011), as exactly the same equipment was used. This error is mainly induced by differences of sampling volume, resulting in an estimated error of 10% (5 ± 0.5 cm^3).

For the LOI determination, the samples were heated to a temperature of 550°C for 4 hours, to burn all organic matter (Heiri et al., 2001). After weighing the samples, the LOI could be established (Appendix 10) by:

$$LOI = (dried\ weight - burned\ weight)/dried\ weight * 100\% \quad (4.1)$$

During sampling of the large core peat samples, two or three sealed samples per location were saved for future compressibility testing (Constant Rate of Strain; CRS). These saved samples include two 30 cm samples from the inner city and multiple 60-100 cm samples from Korte Akkeren and the rural area. The CRS test requires undisturbed samples with a length of 4.5 cm. The saved samples were, therefore, selected based on the length of the undisturbed parts of the peat samples (at least 10 cm without cracks). Furthermore, it would be interesting to compare the difference in compressibility throughout the peat layer. So, all four locations, a sample closest to the top and the base of the peat layer (without too many ruptures) were kept behind. For the two locations in Korte Akkeren a third sample was saved from the center of the peat sequence, to better describe the progression in compressibility throughout the peat layer.

4.2.2 Quantifying current degree of consolidation

The current degree of consolidation of the four different locations was acquired using the empirical relations between LOI, ρ_{dry} and consolidation, found by Van Asselen (2011). Consolidation is defined as the percentage of volume reduction (h_{red}) to the original thickness (h_0):

$$Consolidation = \frac{h_{red}}{h_0} \tag{4.2}$$

where h_0 can be calculated using the relations found by Van Asselen (2011). First the original unconsolidated dry bulk density ($\rho_{dry,uncons}$) of the 5 cm^3 samples is calculated using:

$$\rho_{dry,uncons} = a - ce^{-(b/LOI)} \tag{4.3}$$

where a, b and c are fitted parameters, based LOI and $\rho_{dry,uncons}$ measurements. For the Netherlands, these parameters are calibrated, based on representative unconsolidated peat samples from Biebrza National Park (Poland) and the Rhine-Meuse Delta (Van Asselen, 2011). This calibration yielded the following parameter values for the western peat area (The Netherlands): $a = 1.5$, $b = 6$ and $c = 1.53$.

Next, the deconsolidated thickness (h_{decons}) of the 5 cm thick peat sample can be calculated:

$$h_{decons} = h_0 = \left(\rho_{dry,cons}/\rho_{dry,uncons}\right) * h_{sample} \tag{4.4}$$

which can be used to express the reduction in thickness ($h_{red} = h_{decomp} - h_{sample}$), which is needed for the calculation of consolidation (equation 4.2) (Appendix 10). The total error for calculating consolidation is estimated to be 15% (Van Asselen, 2011).

4.3 Data processing

4.3.1 Generation of a 3D representation of the subsurface build-up

In order to determine which mechanisms are dominant causes for subsidence in Gouda, as well as to assess the effect of differences in subsurface build-up on the subsidence potential, an accurate 3D representation of the lithological subsurface architecture is required. That is why the lithological knowledge obtained in this study was converted into a three-dimensional lithostratigraphic subsurface model. The model was generated in two main steps. First, a rough initial model was manually built in iMOD, using flat surfaces based on average depths of layer interfaces. Secondly, the initial model was fine-tuned by interpolating data points, creating a more natural representation of the interfaces. The initial model gave a rough indication and overall overview of the subsurface architecture. This enabled judgment of the altered model by examining if it still suited the general subsurface build-up.

This section describes the complete process of constructing the 3D lithostratigraphic model. It starts with the selection criteria for the software that is used, followed by the construction of cross-sections and a paleogeographic reconstruction of the Holocene channel belts to generate insight in the subsurface build-up. Subsequently, the boundaries of the model are discussed, followed by the discussion on the development of the different stages of the model. This section is then concluded with the description of the quality assessment of the model compared to the publically available subsurface model of the Netherlands (GeoTop; TNO, 2014).

Software selection

A software package called "iMOD" (Vermeulen, Burgering, Roelofsen, & Minnema, 2016) was selected to produce the lithostratigraphic model. The selection was based on two main criteria: 1) the selected software had to support easy insertion of new data and adjustment of an existing model or layers. Such flexibility is needed, as urban loading in Gouda calls for a detailed subsurface model. Yet, the amount of available data is relatively low, so future data should be easily incorporated into the model to enable further development. 2) The lithostratigraphic model should be able to serve as a boundary condition for further groundwater and subsidence modeling.

iMOD meets both criteria, as it is both flexible and equipped with different groundwater and subsidence modeling-packages; MODFLOW and SUB-CR, respectively. Additional data can be easily added and both interactively displayed and edited in a 2D and 3D environment. This makes iMOD an ideal software package for 3D reconstruction of the subsurface in a complicated aggraded delta with multiple shifting channel belts, like the Rhine-Meuse Delta.

Cross-section and channel belt reconstruction

To gather initial insight in the subsurface build-up, three cross-sections (Addendum 1 to 3) were constructed based on general concepts of delta evolution, the regional geological history, and available core descriptions. The core descriptions were obtained from both Van Dasselaar et al. (2013) and the fieldwork described in section 4.1.1. Each core was divided over several lithostratigraphic units based on the overall differences in lithological properties and other characteristics described in the core logs. Subsequently, all corresponding units were connected, using the concepts of delta evolution, to form a realistic representation of the subsurface build-up.

Only four of the lithological cores reached the Holocene or Pleistocene fluvial sands (base of the model). To still give a good representation of the sandy layers of the Holocene channel belts and the Pleistocene terraces, an additional data source was needed. Therefore, Cone Penetration Tests (CPTs) were incorporated to gain insight in the exact sand depths of the different channel belts. CPTs are more common than geological cores in urban regions, as they are often conducted before construction takes place, which is also the case for Gouda.

The transition from peat or clay deposits to sand deposits can easily be recognized in CPT data. At this transition the cone-resistance spikes, as clay and peat offer little resistance to the CPT rod, while sand offers large resistance (Robertson & Cabal, 2015). The used CPTs were acquired from the internet portal of the Dutch geological survey; DINOloket (TNO, 2014). In total, 223 CPTs were gathered situated both in the research area and adjacent regions. By also using data from outside the research area, the course of the channel belts and the associated sand depths were more accurately determined, as the bigger picture was considered.

As the transition from clay or peat to sand was not equally distinctive in each CPT, a selection was made. To minimize uncertainty, only the 149 CPTs with a clear transition from soft to sandy deposits were used (Appendix 7). Together with a nearby cross-section established by Hijma et al. (2009) (Figure 3) and the paleogeographic reconstruction of the Rhine-Meuse Delta (Cohen et al., 2012), the channel belts were reconstructed as detailed as possible. In this process, the accurate CPT data was leading, while the more general paleogeographic reconstruction by Cohen et al. (2012) and the cross-section by Hijma et al. (2009) were used as guidelines. The cross-section by Hijma et al. (2009) was used to assess the approximate depth at which different channel belts are situated in the subsurface. Hijma et al. (2009) used both cores and CPT data to construct the cross-section. However, CPT data was not taken into consideration in the original paleogeographic reconstruction (Cohen et al., 2012). Consequently, the new regional reconstruction is of a higher accuracy than the original one.

Model boundaries and layers

The lithostratigraphic model covers the inner city and the district of Korte Akkeren. The rural area is not included, as the rural area was only used as a reference point, while the main focus of this study lay on the urban area. Most boundaries are formed by water bodies (Figure 17), such as canals and the residual channel of the Hollandse IJssel. Just the northern part of Korte Akkeren is confined by a road; the “Reigerstraat”.

The basement of the model was placed within the first aquifer, which consist of fluvial sand and gravel deposits from the Pleistocene and Early Holocene (Kreftenheye and Echteld Formation, respectively). Both The Pleistocene and Early Holocene sand deposits are connected, as the Holocene channel belts incised into the Pleistocene terrace, making both deposits part of the same aquifer. The top of the sandy deposits is situated between 8 to 13 meters below mean sea-level. Consequently, the base of the model is located at 15 m-NAP, to include room for some local variations in sand depth.

A cell size of 10 x 10 meters was chosen for the lithostratigraphic model. This relatively high resolution was needed in order to capture the high spatial differences in subsurface build-up.

The lithostratigraphic layers distinguished in the model are chosen based on the main subsurface layers encountered during the field campaign and the cross-section interpretations. The model is devised in five main units, with several sub-units (section 5.1). The five main distinguished units are:

1) the anthropogenic layer deposited to counteract vertical land movement.
2) recent fluvial deposits of the Gouwe and Hollandse IJssel (Echteld Formation).
3) the peat layer (Nieuwkoop Formation).
4) Holocene fluvial deposits from the Gouderak and Zuidplas channel belts (Echteld Formation).
5) deposits of Pleistocene age (Kreftenheye Formation).

Initial model design

The knowledge obtained from both the core-based cross-sections (Addendum 1 to 3) and the new channel belt reconstruction was processed into a rough initial model. The model layers were constructed by merging different, manually composed, layers for various sub-regions (e.g. city district or channel belt) (details of each layer given in Appendix 8A). This approach was chosen because layers show significant spatial variance between regions. For instance, the top of the peat is occurs significantly deeper in the inner city than in Korte Akkeren, due to the longer period of loading. The top of the first aquifer (Pleistocene and Early Holocene sands), on the other hand, depends on the location of the different channel belts, as the top of the sandy deposits is different for each channel belt.

Finally, the depths of all water bodies (e.g. canals and the Hollandse IJssel) (Rijnland Waterboard, n.d.) were superimposed on model. Four recent large scale anthropogenic sand fills were observed in several core descriptions: 1 and 2) the filling of two former canals at the "Nieuwehaven" and "Raam" (core 041 and cores 003, 004 and 005, respectively), 3) an archeological excavation at "Verlorenkost" (core B004) and 4) a building site between the "Westerkade" and "Snoystraat" (core B005A). These recent sand fills were also superimposed on the "recent anthropogenic" model layer. With these final changes, the initial model was completed (Appendix 8B)

Model fine-tuning

The fine-tuning of the initial model was done using the iMOD "solid-tool". This tool enabled the display and alteration of a collection of layer (IDF-files). The alteration of layers is based on the construction and interpolation of multiple cross-sections (Figure 19). In these cross-sections, the correlation of the different layers can be manually adjusted in order to fit the borehole data. Additional nodes can be created and dragged to create a smooth interface for each layer in each cross-section.

The solid tool uses a default kriging interpolation to recalculate the model interfaces. Kriging is a statistical interpolation technique, which uses a weighted average of several points to calculate each cell value (Davis, 2002). The weight of each point is assigned based on the distance to the cell in question. More precise, kriging uses a semivariogram model which describes over what distance the variance in a dataset can be predicted. This translates into a high weight for nearby points and a flattening decrease in weight assigned to a point with increasing distance. At a certain distance the variance can no longer be described by a certain point.

The interpolation in iMOD only uses the knick points (nodes) defined in the cross-sections. Therefore, the use of more nodes within each cross-section results in model interfaces which are in better accordance with the general insight on the subsurface build-up.

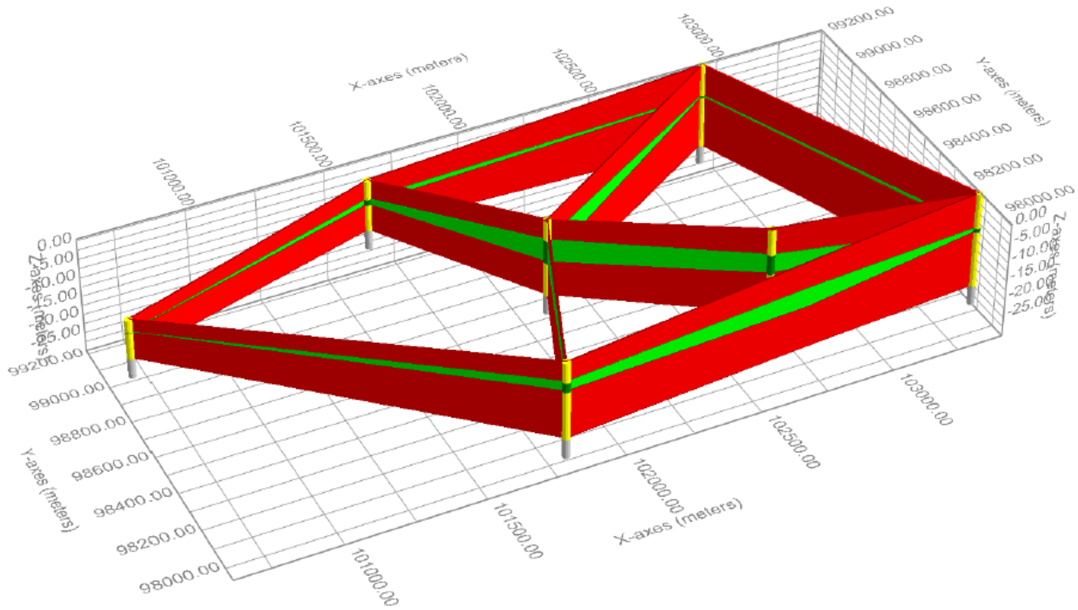


Figure 19 Image of the iMOD solid-tool, where cross-sections are first adjusted based on core data and subsequently used to interpolate new model interfaces. Image obtained from the iMOD manual.

Besides the use of extra nodes, a maximum amount of points used to calculate a cell value was imposed upon the default kriging settings. The benefit of using a lower amount of data points during interpolation is that only close points are used to compute the new layers. Therefore, the new interfaces agree better with the imposed cross-sections. However, the use of too few points results in sharp scarps in the areas between the cross-sections. After experimenting with the maximum amount of points used to compute the value of each cell, the resulting layers were compared with the naked eye. This comparison indicated that a maximum of 15 points gave the best results. With the imposed maximum of 15 nodes per cell, the new interfaces agree well with the cross-sections and the areas in-between look realistic and smooth as well.

Model interfaces get smoothed, as kriging uses multiple points to compute the cell values between several cross-sections. This is not favorable for the hard boundaries set between, for instance, the top of the peat layer in the inner city and Korte Akkeren (different depths due to longer loading). To overcome this problem, model layers were split into multiple individual sections (e.g. the inner city and Korte Akkeren or based on channel belts) by using sharp boundaries, called faults. These faults were entered into the solid-tool, creating different areas in which separate interpolation takes place. For instance, the interface between peat and the anthropogenic deposits in the inner city was recalculated using solely points situated within the inner city. Faults were also used to force the interpolation of the fluvial deposits to follow the course of the channel belts. This causes steeper gradients between the sandy channel/bar and natural levee/floodplain deposits of two different channel belts (e.g. sand deposited by the younger Zuidplas channel belt is situated closes to the current surface level, compared to the sandy Gouderak deposits).

The top layer of the lithostratigraphic model was not recalculated, as it is directly derived from the Dutch digital terrain model (build-up areas filtered out) (AHN, 2014). The interfaces describing the Pleistocene deposits were also not interpolated, as no cores were available to base the cross-sections on (only two cores reached the Wijchen member, and no cores reached the Kreftenheye sands). Consequently, the top layer, as well as the Pleistocene layers remained unchanged compared to the initial model.

After interpolation, some manual adjustments had to be made, as small scale features were lost due to the smoothening character of kriging. Features lost by this effect include the channel fill and sand deposits of both the Gouwe and Hollandse IJssel, and the manually imposed sand fills. These features were recovered by cutting out the cells where these features should be located. Thereafter, the holes in the model layers were filled again with the values used in the initial model (Appendix 8). The base depths of the different water bodies did not have to be adjusted manually, as the top layer was not recalculated. Some water bodies cross into the top of the historical anthropogenic layer, which was recalculated. However, the base levels of the water bodies were already incorporated in the top of the historical anthropogenic layer, because iMOD checks each layer with respect to the overlying interfaces.

Although iMOD ensures that successive layers do not cross each other, the manual adjustments did lead to crossing interfaces. To restore the layer succession a Batch-tool called “IDFCONSISTENCY” was used. A Batch-tool is a tool which runs in iMOD-Batch mode, outside the standard iMOD interface. The IDFCONSISTENCY tool checks successive layers (IDF-files) on their consistency. In other words, the script checks if the base of one layer is equal to the top of the underlying layer. If not, the top of the underlying layer is set equal to the base of the other layer, for the deviating cells. With this final step, the 3D lithostratigraphic model was completed.

Model quality

The quality of the model was assessed by comparing the previous model versions and datasets (e.g. GeoTop and the archeological dataset) for the inner city area, as this region has the largest spatial variation in subsurface build up. For each previous model version the layer thickness and volume of the peat and anthropogenic layer were compared to the final 3D model, which offers the most accurate representation of the subsurface of Gouda. Only the peat and anthropogenic layer were analyzed since these are the most important layers for computing subsidence caused by urban loading. In other words; the added value of additional data use, relative to the GeoTop model, was assessed by comparing the thickness and volume of the peat and anthropogenic layer for each step of increased data density or geological insight.

The layer interfaces of the GeoTop model were obtained from the iMOD subsurface explorer, which enables the loading of GeoTop into iMOD. For the archeological data, the thickness of the anthropogenic layer was obtained from Figure 8, and the thickness of the peat layer was computed using default kriging interpolations to quickly obtain the top and base of the layer. For the constructed initial- and final 3D model, the top and base interfaces of the specific layers could be used. The volume of the different units was calculated by summing the thickness of each cell multiplied with the cell surface (m^2) of the data set in question.

4.3.2 Unraveling the subsidence signal

To find the main mechanisms and drivers responsible for the observed subsidence in Gouda, knowledge on both the different processes and the subsurface build-up are important. The literature research on the different subsidence mechanisms and drivers (Chapter 3) already concluded that consolidation due to urban loading and oxidation are the most likely main mechanisms. However, the question remained if the peat underneath Gouda would still be subjected to oxidation, as a thick layer of anthropogenic deposits covers the peat.

To evaluate whether oxidation could still stake place, the depth of the lowest groundwater levels was compared to elevation of the top of the peat layer. The lowest groundwater measurements over 2016 were extracted from the time series of 53 groundwater monitoring wells (situated throughout Korte Akkeren and the inner city) (Wareco, 2017). The extracted lowest groundwater levels were subsequently interpolated over the inner city and Korte Akkeren separately, as different groundwater levels are maintained in both districts (Appendix 2).

In order to compare the lowest groundwater levels to the elevation of the top of the peat layer, the two separate interpolations of the lowest groundwater level in the inner city and Korte Akkeren were merged. Subsequently, to assess whether the peat layer could be aerated (during warm periods) the difference between this merged representation of the lowest groundwater levels and the depth of the top of the peat layer (modeled interface) was computed. Based on this computation it could be assessed whether only consolidation or both consolidation and oxidation are responsible for the observed subsidence in Gouda.

4.3.3 Quantification subsidence potential

To quantify the subsidence potential of the different sub-regions of the research area, the mean degree of consolidation of each sampling location was calculated based on the values of all analyzed peat samples per core location (section 4.2.2). The average consolidation of each location was subsequently used to assess the subsidence potential by calculating the loss of peat volume due to an increase in consolidation as a result of: 1) reaching a maximum degree of consolidation, and 2) adding an additional load to the peat. The exact methodology to assess the subsidence potential according to these two approaches is described below.

Subsidence potential based on a maximum degree of consolidation

To assess the maximum degree of consolidation, needed to calculate the subsidence potential, this study examined the average degree of consolidation of the inner city. The inner city has experienced urban loading for the last 750 years, together with continuous land-level raising (to compensate for subsidence), this resulted in a very dense peat layer below the anthropogenic layer (section 0). Consequently, it can be assumed that the peat underneath the inner city has approximately reached its maximum consolidation. This assumption is also supported by the relatively low subsidence rates in the inner city. Based on assumed maximum consolidation, the expected subsidence for Korte Akkeren and the rural area could be calculated, by taking the average degree of consolidation of core B002 (inner city) as an approximation of the maximum state of consolidation.

In other words; the amount of reduction in peat thickness was calculated for the hypothetical case that the urban loading in Korte Akkeren and the rural area would reach the same effective stress (weight) as the inner city is experiencing. First, the difference in average consolidation between the inner city and each of the other locations was taken. Then, this difference was transposed back into thickness loss using equations 4.3 and 4.4 to calculate the original peat thickness (t=0). Subsequently, the known average degrees of consolidation at t=1 (current conditions) and t=2 maximum state of consolidation; inner city) were used to compute the expected maximum subsidence for the different regions. In equations, this is expressed as:

$$\Delta consolidation = consolidation_{t=2} - consolidation_{t=1}$$

$$\Delta consolidation = \frac{h_{red,t=2}}{h_0} - \frac{h_{red,t=1}}{h_0} = \frac{h_{red,t=2} - h_{red,t=1}}{h_0}$$

as the maximum expected subsidence is the difference between the current thickness and the thickness at maximum consolidation, this can be written as:

$$subsidence_{max} = \Delta consolidation * h_0$$

where, h_0 can be calculated by inserting the average values of the measured LOI and ρ_{dry} into equations 4.2 and 4.3, for each location separately.

Subsidence potential based on increased loading

In addition to the estimated maximum subsidence, the effect of added effective stress due to land-level raising was assessed for three scenarios; adding 25 cm, 50 cm and 100 cm of sand. This assessment is based on the average current degree of consolidation and the effective stress exerted by the anthropogenic layer.

The effective stress (σ’) exerted by the anthropogenic layer was calculated for each of the four locations using Terzaghi’s formula (Terzaghi, 1943):

$$\sigma' = \sigma - u \qquad (4.4)$$

where, σ is the total stress and u is the pore water pressure, both in Pa. σ and u are calculated by:

$$\sigma = h_s \cdot \rho_s \cdot g \tag{4.5}$$

$$u = h_w \cdot \rho_w \cdot g \tag{4.6}$$

where, h_s and h_w are, respectively, the thickness of the overlaying sediment layer and water column (m), ρ_s is the saturated density of the overlaying sediment (kg/m^3), ρ_w is the density of water (1000 kg/m^3) and g is the gravity constant (9.81 m/s^2). To calculate the total effective stress exerted by the anthropogenic layer, the contribution of each lithological layer (Appendix 6) was calculated separately using the corresponding ρ_s values (Table 2) and, subsequently, summed.

Table 2 Standard saturated density (ρ_s) values for different lithological classes, adopted from Van Asselen (2011).

	Peat low mineral content	**Peat** weakly clayey	**Peat** very clayey	**Clay (silty)**	**Loam**	**Sand**
Saturated density [kg/m^3]	1029	1087	1171	1702	1885	2089

To assess the amount of increase in consolidation, due to the increase of effective stress for each scenario, the mean consolidation of each location was plotted against the effective stress. A logarithmic regression line was fitted through the data points, which made it possible to assess the increase in consolidation caused by a certain increase in effective stress. Changes in groundwater level were not incorporated in this calculation, as no hydrological modeling was incorporated. The weight added to the anthropogenic layer was, therefore, calculated by multiplying the added thickness with the ρ_s of sand.

The subsidence generated by land raising, was again calculated using:

$$subsidence_{max} = \Delta consolidation * h_0$$

where, Δconsolidation was calculated using the logarithmical regression line. The degree of consolidation that should be reached after the additional load is added, was derived from the logarithmic relation. The measured average consolidation values are, however, not projected exactly on the regression line, as this line is never a perfect fit. To compensate for their deviation, these measured average consolidation values were projected onto the logarithmic regression line. This enabled unbiased comparison of the subsidence potential of the different sampling locations.

5 Results and interpretations

In this chapter, the results of this study and their general interpretations are presented. This section starts with the results on the subsurface build-up (section 5.1), followed by the results on the unraveled subsidence signal (section 5.2) and the results on the consolidation and subsidence potential (section 0).

5.1 Subsurface build-up

This section starts with a description of the results on lithological build-up, followed by the description of the sand depths of the different channel belts and the constructed 3D lithostratigraphic model. For the description of the lithological results, first the distinguished lithostratigraphic units are presented, followed by the lithostratigraphic cross-sections. In the section on the sand depths, first the depths of the sandy channel belt deposits are presented, followed by the new paleogeographic reconstruction of the channel belts. In the part of this section the 3D lithostratigraphic model is presented, as well as its accuracy compared to other representations of the subsurface of Gouda.

Lithostratigraphic subsurface build up

To create a good representation of the subsurface build-up, the subsurface has to be divided in different lithostratigraphic units. Based on the lithological core descriptions five main units were distinguished, with each several sub-units:

1) The anthropogenic layer deposited to counteract vertical land movement, which contains the following sub-units:
    i. The recent anthropogenic layer, containing clean marine sands, gravels and garden mould.
    ii. The historic anthropogenic layer, consisting of regional materials like peat and clay with plenty archeological admixture.
2) Recent fluvial deposits by the Gouwe and Hollandse IJssel, which both incised into the underlying peat layers. This layer contains two sub-units combined from two kinds of deposits with similar hydrological properties:
    i. Sandy channel bed and point bar deposits.
    ii. Fluvial channel fill and natural levee deposits, consisting of silty clay deposits.
3) The peat layer, containing the following sub-units:
    i. A layer of peat turbated by human activities, which contains traces of archeological admixture and has a lower organic matter content and less distinguishable plant remains due to decomposition when the peat was aerated at the land surface.
    ii. An upper peat layer. This layer is situated underneath the turbated peat layer or the fluvial deposits of the Gouwe and Hollandse IJssel.
    iii. A traceable clay layer of about 2 to 10 cm thick, deposited by a fluvial flood event.
    iv. A lower peat layer, deposited before the fluvial flood event.
4) Holocene fluvial deposits from the Gouderak and Zuidplas channel belts, containing:
    i. Clayey floodplain and natural levee deposits. These two units were merged as they are hard to distinguish and have similar hydrological and lithological properties.
    ii. Channel bed and (point) bar deposits, consisting of sands.
5) Deposits of Pleistocene age:

i. The Wijchen Member, consisting of sandy clay deposits with soil formation characteristics.
ii. The sandy fluvial deposits of the Kreftenheye formation.

After the lithostratigraphic units were defined, the three cross-sections were constructed (Figure 20). The depths of the sandy deposits from the Holocene channel belts and the Pleistocene Kreftenheye Formation were found in only 4 cores. Therefore, they are illustrated without color to indicate the approximate build-up of the deeper subsurface. These approximate mean depths were copied from the new paleogeographic sand depth map (Figure 21), which is presented in the following section.

From the cross-sections several general differences in subsurface architecture can be observed which vary between; the different channel belts, the inner city and Korte Akkeren, and areas with or without deposits of the Gouwe. These differences will be presented below from the deep to shallow deposits.

When looking at the top of the Holocene natural levee and floodplain deposits a gradual increase in depth can be observed with an increasing distance from a higher elevated channel belt (cross-section A: Figure 20). In cross-section A, the depth of the top of the natural levee and floodplain deposits situated above the Gouderak channel belt is rather constant until core 030, after which the depth gradually increases from 8 to 10.3 m-NAP. Additionally, differences of 2 meter are observed in the top of the Holocene natural levee and floodplain deposits (e.g. above the Zuidplas channel belt in cross-section A; Figure 20).

The peat is situated directly on top of the Holocene natural levee and floodplain deposits. Therefore, the base of the peat layer follows the same pattern as the top of the underlying fluvial deposits. The depth of this base ranges from about 5.5 to 8.5, from 7.8 to 9, and from 9.5 to 11.3 m-NAP for the Zuidplas, Gouderak and Pleistocene channel belts, respectively (Figure 20).

Within the peat layer several humic clay horizons are observed. The thickness of these clay layers ranges from a couple of centimeters (e.g. core B008 at 8.06 m-NAP) to a maximum of 30 cm in core 051 (at 4.90 m-NAP). Generally, the thick clay layers contain a high concentration of plant remains (mostly reed), while the thin layers are only humic. These clay horizons occur at a depth fluctuating between 7.5 to 9 m-NAP in the northeast of the study area, around 7 m-NAP in the rural area (B012) and around 5 m-NAP for core 051, south of the Hollandse IJssel (Figure 20).

The clay horizons present in the north and northeast of the study area (7.5 to 9 m-NAP) are probably deposited during a flooding event of the Waddinxveen channel belt. Bothe the location (northeast of the research area) and the top depth (6.5 to 9.5 m-NAP; Cohen et al., 2012)of the Waddinxveen channel belt deposits correlate well with the depth and location of the clay horizon.

The clay horizon in the south (core 051) at a depth of 5 m-NAP is probably deposited by the younger Haastrecht channel belt which is situated to the southeast of the research area. Additionally, the depth at which the upper Haastrecht deposits are found is at approximately 4.4 to 4.7 m-NAP (Cohen et al., 2012), which relates well to the depth of the clay layer in the south.

At the rural area (core B012) the clay horizon is situated a little higher at 7 m-NAP. This clay layer is considered as a Waddinxveen clay deposit, despite the fact that the Waddinxveen channel belt is located relatively distally. The higher elevation of the clay deposit (compared to the other layers in cross-section E; Figure 20) might be explained by the low amount of loading in de rural area, causing the peat underlying the clay to be less compressed. Alternately, the clay could be deposited by the Haastrecht channel belt in a low lying region of the distal floodbasin.

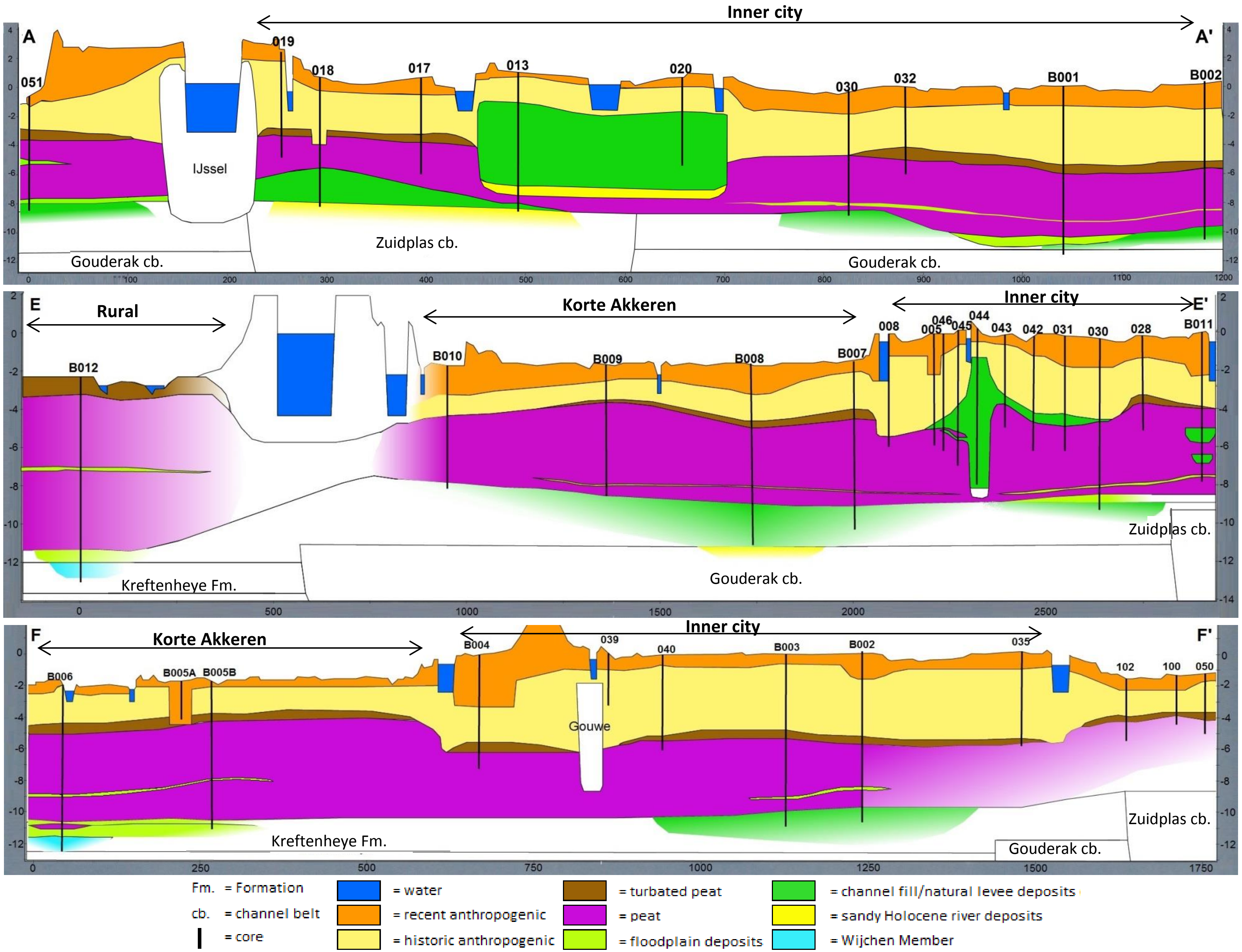

Inner city
A
A'
051
019
018
017
013
020
030
032
B001
B002
IJssel
Zuidplas cb.
Gouderak cb.
E
Rural
Korte Akkeren
Inner city
E'
B012
B010
B009
B008
B007
008
005
046
045
044
043
042
031
030
028
B011
Zuidplas cb.
Gouderak cb.
Kreftenheye Fm.
F
Korte Akkeren
Inner city
F'
B006
B005A
B005B
B004
039
040
B003
B002
035
102
100
050
Gouwe
Kreftenheye Fm.
Zuidplas cb.
Gouderak cb.
Fm. = Formation
cb. = channel belt
= core
= water
= recent anthropogenic
= historic anthropogenic
= turbated peat
= peat
= floodplain deposits
= channel fill/natural levee deposits
= sandy Holocene river deposits
= Wijchen Member

Figure 20 (previous page) Schematized lithological cross-sections A2, E2 and F (Addendum 1, 2 and 3). The exact course of each cross-section is illustrated in Figure 17. Within each cross-section the different lithostratigraphic units are indicated (see legend). Furthermore, the white polygons are interpreted based on other data (e.g. archeological interpretations and CPT data) than the cores, which are indicated by the black vertical lines.

The top of the peat layer varies greatly in depth between the different sub-regions of the research area. In the rural area peat is situated up to the surface level (2.3 m-NAP), while in Korte Akkeren the top of the peat layer ranges gradually between 3.5 to 4.5 m-NAP. In the inner city gradients in peat depth are less gradual. In general, the depth of the peat interface is situated between 4.5 and 5.5 m-NAP in the north of the inner city, and decreases in southeastern direction to about 3.5 m-NAP.

Young floodplain and natural levee deposits are only found on top of the peat layer close to the Gouwe. Even in the cores closest to the IJssel, no fluvial deposits were encountered (e.g. core 019). The floodplain deposits from the Gouwe are approximately 0.5 m thick (cross-section E; Figure 20).

The Hollandse IJssel probably formed narrow natural levees, preventing thick floodplain deposits to form. The overbank deposits of the Gouwe must have formed by sediment from the Hollandse IJssel that was transported upstream during floods, as the sediment load of the Gouwe must have been low (natural peat drainage channel).

The anthropogenic layer also varies in thickness within each region. In the rural area no anthropogenic layer was found, apart from a turbated top layer. In Korte Akkeren the base of the anthropogenic layer is situated between 3.5 and 4.5 m-NAP, which results in a layer thickness of 2.1 to 2.9 meters. In the inner city the bottom of the anthropogenic layer is situated at a maximum depth of 5.5 m-NAP in the north. The anthropogenic layer is situated directly on top of the peat, in most cases. Therefore, it follows the same pattern as the top of the peat, resulting in a decreasing base depth in southeastern direction. This causes a decrease in anthropogenic layer thickness from 6 meters in the north of the inner city to 3.5 meters in the southeast (e.g. archeological core 017). Additionally, the anthropogenic layer is also relatively thin above the deposits of the Gouwe, with a thickness of approximately 1.5 to 2.3 meters (e.g. archeological cores 013, 022 and 044)

In contrast to the historical anthropogenic layer, the recent anthropogenic deposits consist mainly of marine sands, gravels and garden mould. The historical deposits on the other hand consist of clay and peat from the region with archeological admixture.

The thickness of the recent anthropogenic layer is drawn rather smoothly, connecting the base depths indicated in each core. However, the recent anthropogenic layer, doubtlessly, is more complicated. A good example is the difference in the thickness of the recent deposits between core B005A and B005B (cross-section F; Figure 20). There is an approximate difference of 2 meters, while the cores are situated less than 50 meters apart. The spatial variability will be more complex than illustrated, due to the fact that the amount of recent deposits will probably differ between each street, sidewalk and building block.

Sand depth

An additional data source was needed to interpret the depth of the sandy channel belt deposits and the sandy Pleistocene deposits, as only four lithological cores reached the sand underneath the floodplain deposits. 149 CPTs were used to determine the depth of these sandy deposits. These sand depths show an overall increase from the southeast to the west (Figure 21A). Additionally, the sand depths do not show a clear correlation between certain sand depth intervals and the associated channel belts in paleogeographic reconstruction by Cohen et al. (2012).

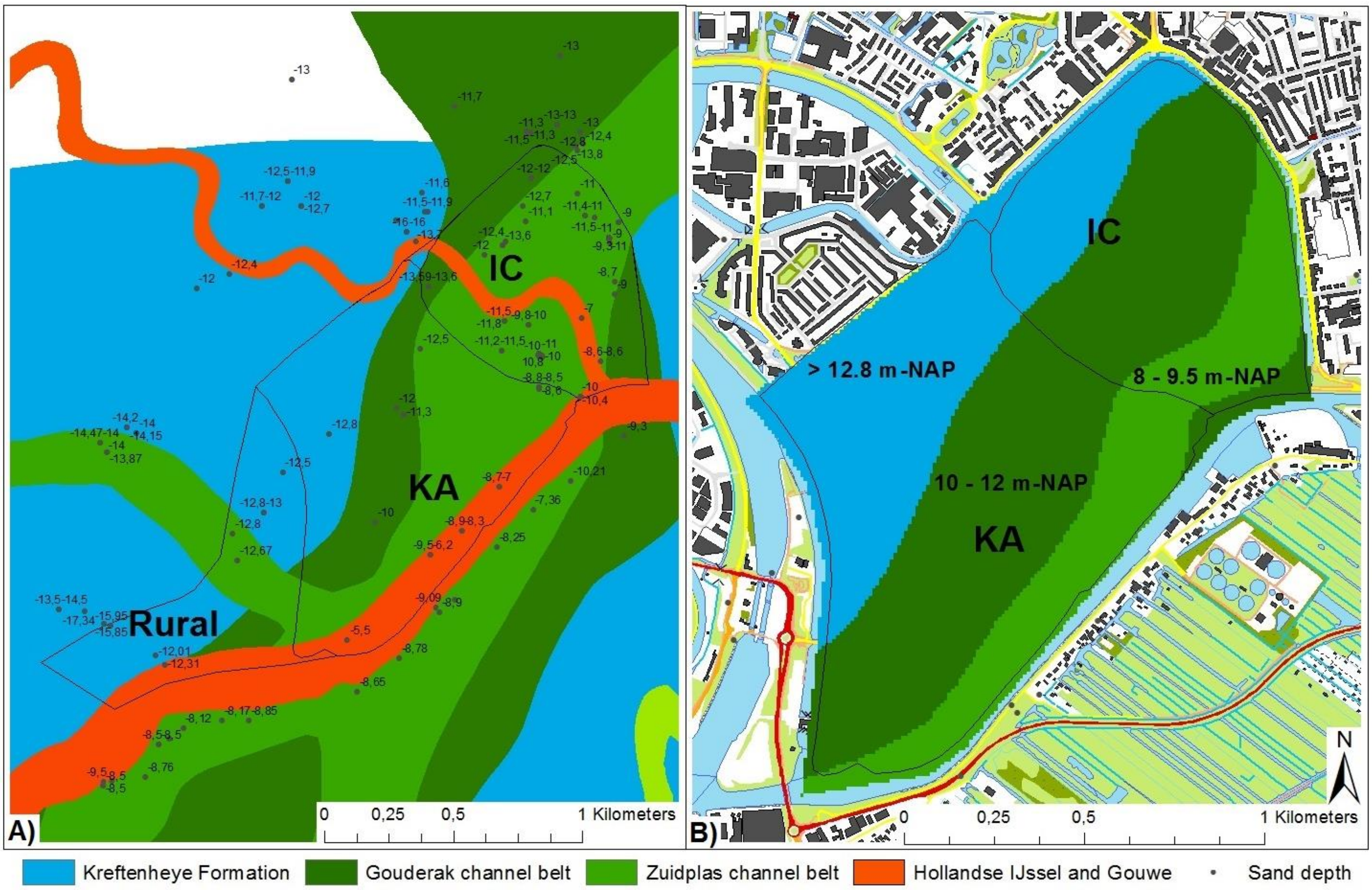


Figure 21 A) Sand depths provided by the CPT data, plotted over the original paleogeographic reconstruction by Cohen et al. (2012). B) New paleogeographic map (based on the CPT sand depths) of the channel belts present in the subsurface underneath Gouda, including the depth intervals of the top of the sand deposits. Additionally, the sub-regions of the research area are also indicated: IC=inner city, KA=Korte Akkeren and Rural=the rural area.

Based on the sand depths, a new paleogeographic reconstruction of the different channel belts underneath Gouda was made (Figure 21B). The distinction between the channel belts (Zuidplas and Gouderak channel belt) and the Pleistocene deposits was mainly based on the depth interval of the top of the sand. Additionally, the original reconstruction was kept in mind as a kind general guideline. The depth intervals attributed to the different channel belts and the Pleistocene deposits were based on the associated general depths described by Cohen et al. (2012), the more region specific depths found in the cross-section by Hijma et al. (2009), and the depths found in the four lithological cores that did reach the sandy deposits. It was concluded that for the Zuidplas channel belt, the top of the sand is situated between 8 and 9.5 m-NAP. For the Gouderak channel belt, this interval lies between 10 and 12 m-NAP. And for the Pleistocene sands of the Kreftenheye Formation, the top of the sand is located at more than 12.8 m-NAP.

Compared to the original reconstruction (Figure 21A), several main differences occur. In the new reconstruction, the Zuidplas channel belt, is narrower and located somewhat more to the south than in the original reconstruction. Secondly, the Gouderak channel belt is also located somewhat more to the south, therefore, the Pleistocene sand is present directly below the Holocene floodplain deposits for the northern part of the inner city at about 12.8 m-NAP.

At some locations, the interpretation of the CPT sand depth was challenging (e.g. northern part of the inner city; Figure 21A), as sand depths differ largely (form 11.3 to 13.8 m-NAP) within a group of neighboring CPTs. Based on the depth intervals defined for each channel belt, these CPTs should therefore be assigned to different units, although this would give a unrealistic pattern. Therefore, boundaries were chosen to give the most realistic reconstruction, based on the further course of the channel belts.

3D representation of subsurface build-up

The lithostratigraphic subsurface model is built using 12 layers, representing the lithostratigraphycal units described for the cross-sections (Figure 22).In the final model the sandy Holocene channel belt deposits, as well as the Pleistocene deposits are represented by flat surfaces, as only four lithological cores reached the sandy deposits and two reached the Wijchen Member (Pleistocene). The depths of these flat surfaces are based on the average depth of the channel belts in the new paleogeographic reconstruction and the two cores reaching the Wijchen Member. These average depths are: 8.5, 11.3, 11.8 and 12.8 m-NAP, for the Zuidplas- and the Gouderak channel belt, the Wijchen member and the Pleistocene sand deposits, respectively.

Additionally, none of the cores acquired, gathered any information on the deposits of the Hollandse IJssel. Therefore, a representative core was selected from DINOloket (TNO, 2014): core B38A0148.

Although the lower model units (Holocene channel belts and Pleistocene deposits) and the deposits of the Hollandse IJssel are not highly accurate (deviation in elevation of about ± 1m), the units most important to subsidence (peat and overlying anthropogenic layer) are accurately modeled. The exact depths of the top interfaces of each unit can be found in Appendix 9.

Figure 23 illustrates the thickness of the anthropogenic layer and the peat underneath the inner city of Gouda, for 4 different stages during the process of constructing the final model. The starting point was the delta wide Dutch subsurface model; GeoTop (TNO, 2014). The second dataset was the local archeological research on the subsurface of the inner city of Gouda (Van Dasselaar et al., 2013). In the third and fourth maps, the data from the initial- and final lithostratigraphic model (both archeological and newly acquired core data incorporated) are illustrated, respectively.

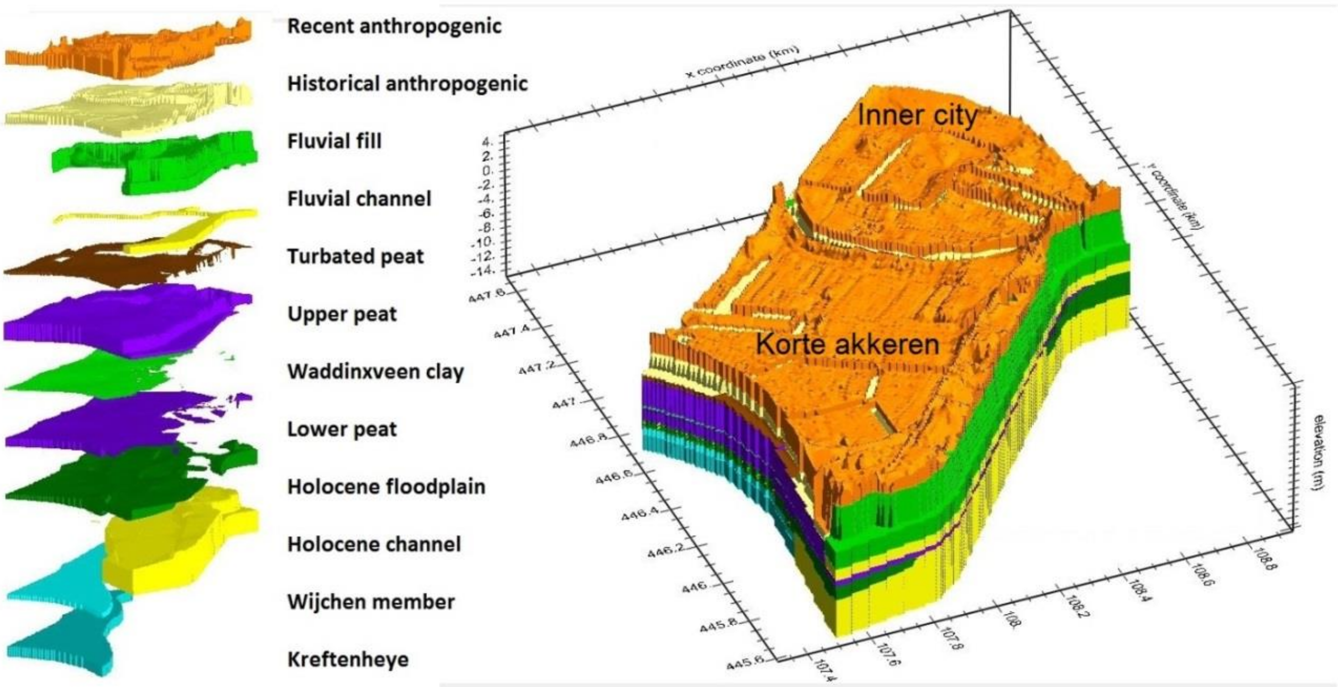


Figure 22 Illustration of the 3D lithostratigraphic model of the subsurface underneath Gouda. Both the inner city and Korte Akkeren can be recognized in the top and lower corner, respectively.

Table 3 Total volumes of the anthropogenic deposits and peat situated underneath the inner city of Gouda. Volumes were calculated by summing the value of each cell multiplied with its cell surface. Calculations were performed for the following datasets (with increasing data density and underlying geological interpretation): GeoTop (TNO, 2014), the archeological study by Van Dasselaar et al. (2013), the initial constructed 3D model and the final 3D model. For each volume, the difference compared to the final model (highest accuracy) is given in %.

		GeoTop	Archeological	Initial Model	Final Model
Anthropogenic Layer	Volume [1000m^3]	1115	2830	2146	2391
	Difference to final model [%]	-53.4%	18.4%	-10.2%	0.0%
Peat Layer	Volume [1000m^3]	3725	2467	3027*	2335*
	Difference to final model [%]	59.5%	5.6%	29.6%	0.0%

* excluding the Waddinxveen clay layer and including the turbated peat

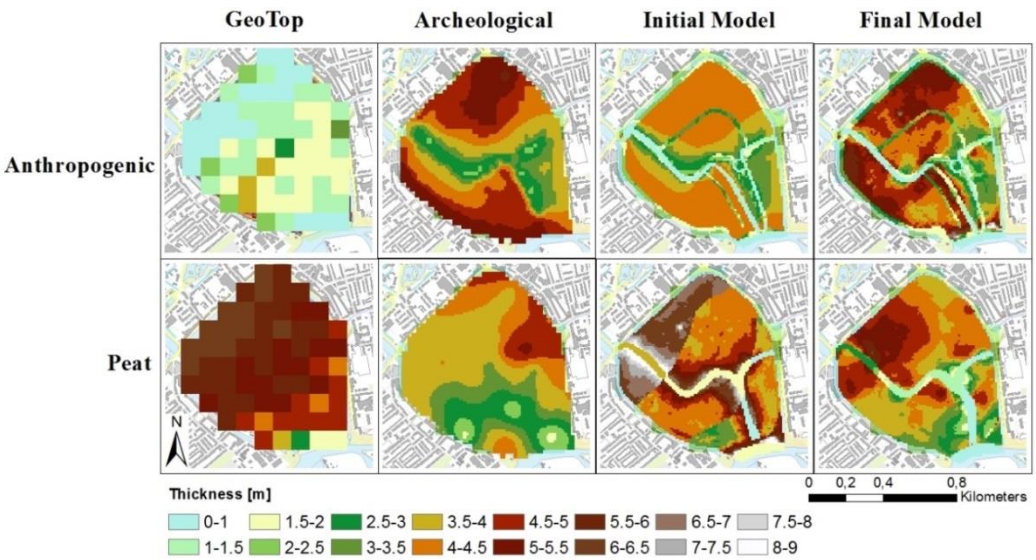


Figure 23 8 maps indicating the thickness of the anthropogenic- and peat layer derived from different datasets with an increasing data density and underlying geological interpretation: GeoTop (TNO, 2014), the archeological study by Van Dasselaar et al. (2013), the initial constructed 3D model and the final 3D model. The GeoTop maps have a cell size of 100x100m, while the other maps have a cell size of 10x10m.

When looking at the general patterns in the anthropogenic layer thickness, the archeological data and both of the newly constructed lithostratigraphic models show the same overall thickness distribution; a shallow anthropogenic layer on top of the Gouwe deposits and a thick layer to the north and (south)west (Figure 23). The anthropogenic layer in GeoTop does not show such a pattern, actually no distinct pattern is observed and the thickness is several meters less than for the other datasets (Figure 23).

The large difference in anthropogenic layer thickness between GeoTop and the best available representation of the subsurface, the final lithostratigraphic model, is also apparent when looking at the difference in layer volume. The volume of the anthropogenic layer in GeoTop is 53.4% less compared to the final 3D model, which corresponds to 1276000 m^3 (Table 3). The archeological dataset and the initial model yield a volume of 18.4% more and 10.2% less, respectively, compared to the final model (Table 3).

For the peat thickness Figure 23 illustrates comparable patterns in thickness distribution between the initial and final subsurface model: thickest peat layer in the northwest and overall decreasing in southwestern direction.

Both GeoTop and the initial model give a peat volume that is 59.5 and 29.6% more, respectively, than for the final model. This corresponds to an overestimation of 1390000 m^3 for GeoTop and 692000 m^3 for the initial model. The archeological data set gives a better approximation of the peat thickness, with an over estimation of 5.6%. However, the general pattern in thickness distribution does not correspond well with the pattern shown by the final 3D model.

5.2 Unraveled subsidence signal

Peat elevation compared to lowest groundwater levels

To determine whether oxidation contributes to the observed subsidence signal, the difference between the lowest groundwater levels and the depth of the peat layer had to be compared. First, the acquired lowest groundwater measurements over 2016 were interpolated for both the inner city and Korte Akkeren (Figure 24A). These interpolated lowest groundwater levels show a lowest level of 2.85 m-NAP in the most southern part of Korte Akkeren, which is about 55 cm below the pursued groundwater level (2.30 m-NAP; Het Gouds Watergilde, 2016). For the inner city the lowest groundwater level is found somewhat to the northwest of the center of the inner city at 1.5 m-NAP, which is 80 cm below the pursued groundwater level (0.70 m-NAP; Het Gouds Watergilde, 2016).

Figure 24B shows the difference between the interpolation of the lowest groundwater levels and the top of the peat layer. This difference shows that, during the lowest groundwater levels, the peat is still situated at least 65 cm below the groundwater. Therefore, the peat layer is always saturated with water, preventing oxidation to take place.

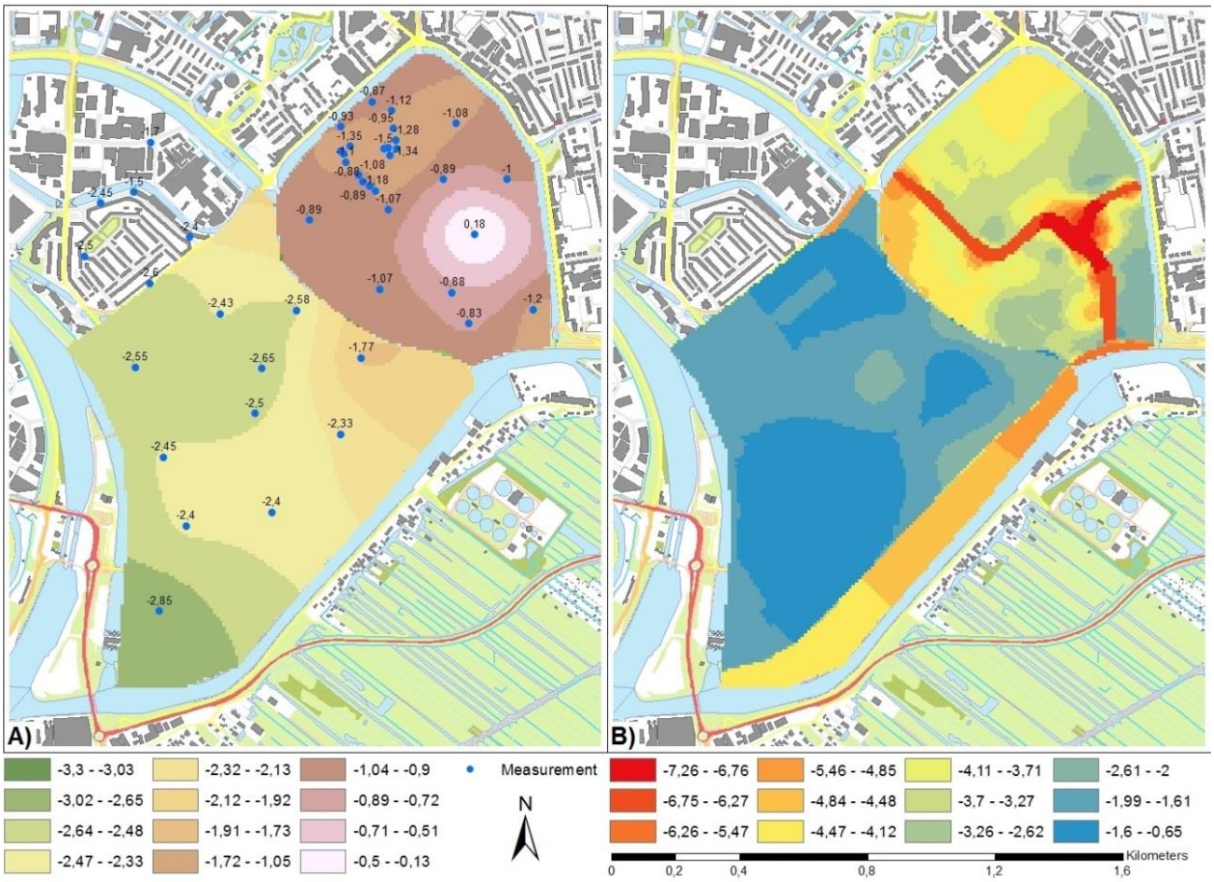


Figure 24 A) Merged interpolations of the lowest groundwater levels measured in the inner city and Korte Akkeren over 2016 (Wareco, 2017). B) Difference between the interpolation of the lowest groundwater levels (figure A) and the top elevation of the peat layer (adopted from the 3D lithostratigraphic model), where negative values indicate that the peat is situated below the lowest groundwater levels.

Unraveled subsidence signal

By combining the conclusions drawn from the chapter 3 and the comparison of the lowest groundwater levels and the peat elevation, the subsidence signal could be unraveled into the individual components. Since oxidation was excludes a contributing mechanism, only three mechanisms remained: tectonics, isostasy and consolidation driven by urban loading.

In chapter 3 it was already demonstrated that isostasy and tectonics only contributed a relatively small amount of subsidence, as their contributions were at least one and two orders of magnitude less than the observed subsidence signal. Therefore, consolidation of the compressible peat layer causes most of the subsidence in the city of Gouda.

The absolute and relative contributions of the contributing drivers was obtained by subtracting the rates caused by both tectonics and isostasy (-0.04 and -0.1 mm/yr, respectively) from the mean observed subsidence rate for each sub-region. The remainder of the subsidence rate in the urban sub-areas is attributed to urban loading. This resulted in an average contribution of 4.6 and 2.15 mm/yr, or 97 and 94% of the total subsidence for Korte Akkeren and the inner city, respectively (Table 4).

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For the rural area, no urban loading was applied to the peat layer. However, oxidation and loading caused by increased effective due to groundwater drainage, did contribute to the subsidence signal. Therefore, the difference between the average subsidence rate of this area and the tectonic and isostatic component is attributed to groundwater drainage (0.26 mm/yr, or 65% of the total subsidence; Table 4).

The unraveled subsidence signal for the three sub-regions of the research area is illustrated in Figure 25. This illustrates very well the large influence of urban loading on the total amount of subsidence taking place. Additionally, the relative contribution of urban loading is less for the inner city (Figure 25 and Table 4).

Table 4 Estimate of the absolute [mm/yr] and relative [%] contribution of each mechanism and driver to the mean measured subsidence rates for each sub-region, within the research area. The contribution of tectonics and isostatics were derived from Kooi et al. (1998). For the city of Gouda the urban loading component is computed as the difference between the mean measured subsidence and the rates caused by tectonics and isostasy. For the rural area the remaining subsidence (besides tectonics and isostasy) is caused by oxidation and loading due to groundwater drainage. The remaining components are assumed to be so small or not existent in the research area, that they are neglected (section 3.3).

	Korte Akkeren		**Inner City**		**Rural**	
	[mm/yr]	[%]	[mm/yr]	[%]	[mm/yr]	[%]
Mean measured subsidence rate (SKY GEO, 2017)	4.74	100.00	2.29	100.00	0.40	100.00
Tectonics	0.04	0.84	0.04	1.75	0.04	10.00
Isostasy	0.1	2.11	0.1	4.37	0.1	25.00
Urban loading	4.60	97.04	2.15	93.88	0	0.00
Surface water drainage*	0	0.00	0	0.00	0.26	65.00
Hydrocarbon extraction	0	0.00	0	0.00	0	0.00
Groundwater extraction	0	0.00	0	0.00	0	0.00
Salinization	0	0.00	0	0.00	0	0.00

* Contains both the oxidation and consolidation component.

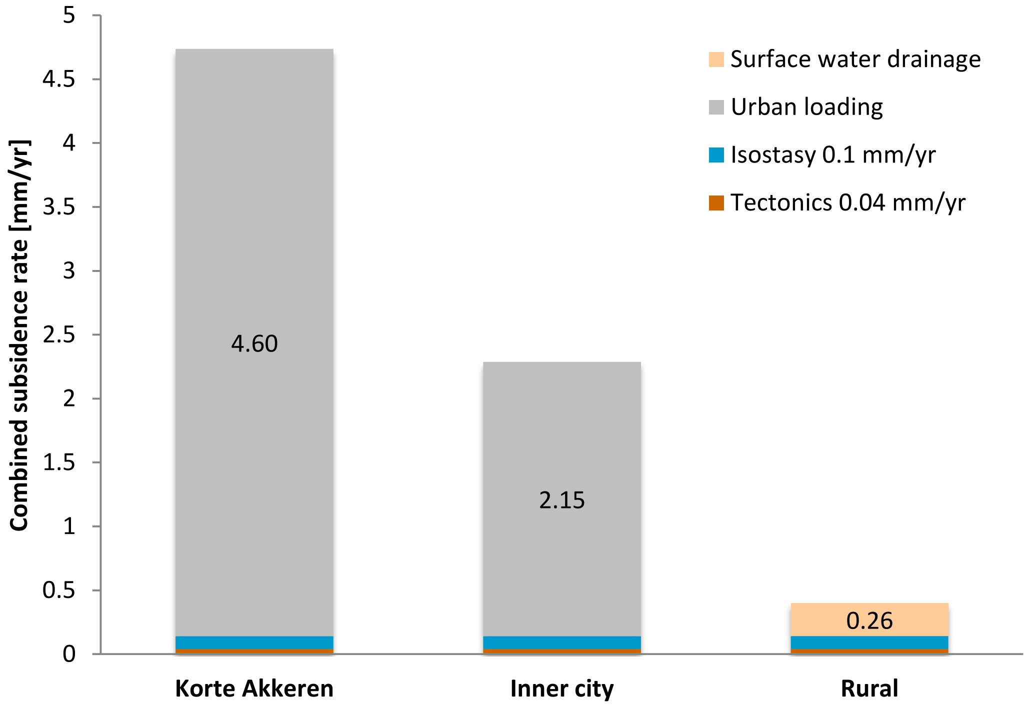

Figure 25 Illustration of the contribution of each driving mechanism active within the research area, relative to the mean measured subsidence rate per sub-region.

5.3 Consolidation and subsidence potential

In this section the results of the consolidation and subsidence calculations are presented. First the current degree of consolidation is assessed, followed by the approximation of maximum amount of subsidence and the effect of added load on the different sub-regions of the research area.

Current degree of consolidation

LOI and dry bulk density measurements of the peat layer (Appendix 10) were used to calculate the current degree of consolidation of the peat underneath the inner city, Korte Akkeren and the rural area (section 4.2.2). Figure 26 illustrates the consolidation degree with increasing depth for the four sampled cores.

The main observation made is the increase in consolidation from the rural area to the inner city (Figure 25). The average degree of consolidation increases from 28.4% in the rural area to 48.3% in the central part of Korte Akkeren, 44.8% in the eastern part of Korte Akkeren and to 57.9% in the inner city.

Additionally, a decrease in consolidation is observed with increasing depth in all four cores. For the inner city the consolidation of approximately 63% at the top, decreases to 52% at the bottom of the peat layer. In Korte Akkeren a decrease from approximately 58 to 41% and from 54 to 34% are observed for cores B007 and B009, respectively. In the rural area, the consolidation decreases from 40 to 20%. In other words; the degree of consolidation decreases with 11% over 3.8 meters in core B002, 17% over 3.5 meters in core B007, 20% over 4.8 meters in core B009, and 20% over 7.9 meters in core B012.

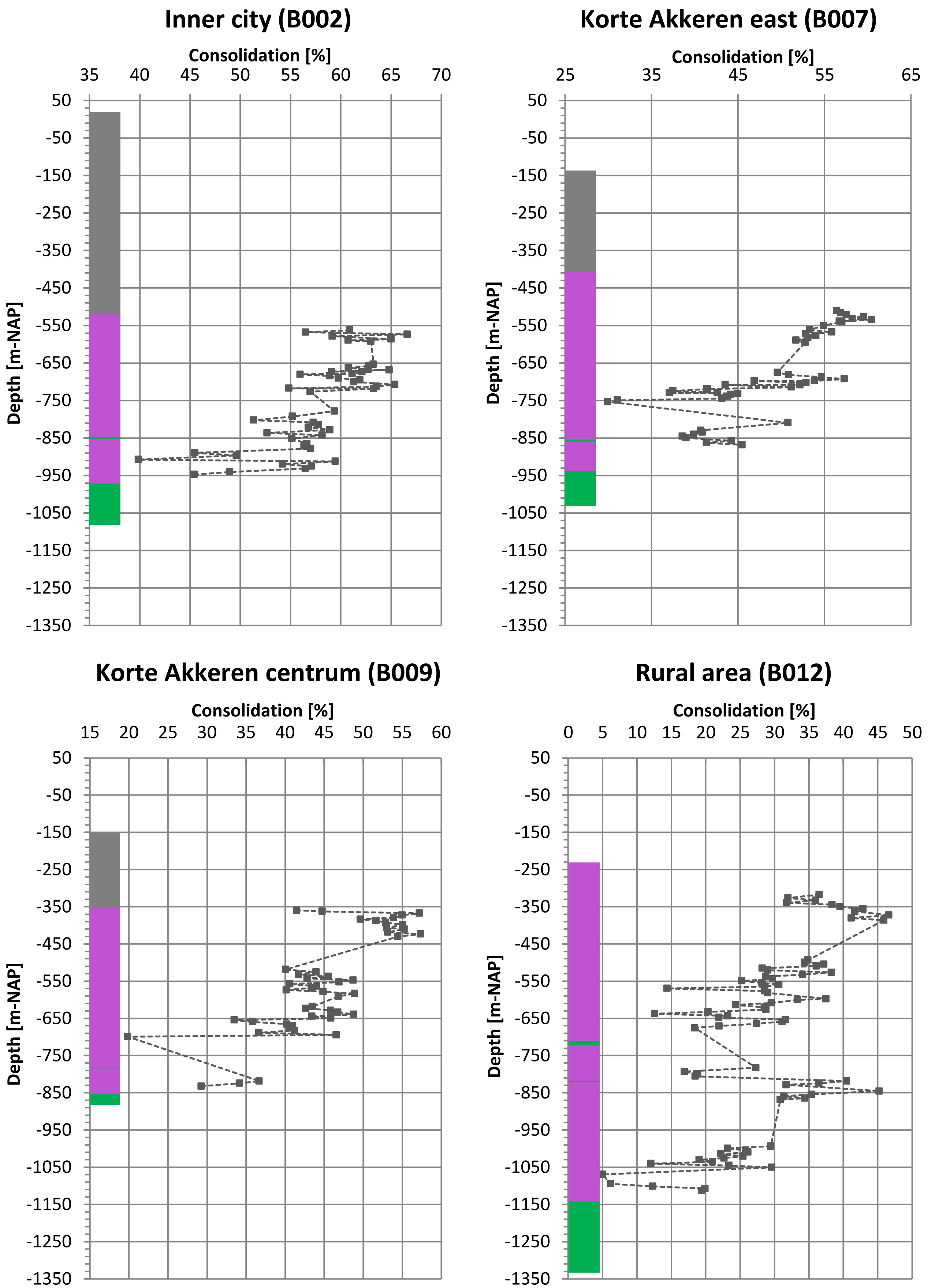

Figure 26 Diagrams illustration of the current degree of consolidation against depth for the four testes cores. Top left: inner city (B002), top right: Korte Akkeren east (B007), bottom left: Korte Akkeren middle (B009) and bottom right: rural area (B012). Along the y-axis of each diagram the main lithological subdivision is illustrated: grey = anthropogenic, violet = peat and green = clay.

Maximum subsidence

The maximum subsidence for each location is calculated using the assumption that the maximum degree of consolidation is equal to the consolidation reached in core B002. Additionally the initial peat thickness had to be calculated, which indicated an original thickness of about 9.5 and 12 meters for the sampled cores in the urban area and the rural area, respectively (Table 5).

The calculated subsidence potential of the different regions decreases from the rural area towards the inner city. That is, the calculated subsidence needed to reach the consolidation state of core B002 (inner city) is: 3.5, 1.2 and 0.9 meters for core B012, B009 and B007, respectively (Table 5).

Effect of added load

The subsidence that might be caused by raising the land-level at the sampled core locations was calculated for three scenarios. In the first scenario 25 cm of sand is added, in the second 50 cm and in the third scenario 100 cm of sand is added at each location.

First the effective stress exerted by the layers lying on top of the peat had to be computed for each core. These calculations yielded an increasing effective stress from about 8200 Pa in the rural area towards 44900 Pa in the inner city. The average consolidation of each sampled core was then plotted against the calculated effective stress of the overlying deposits (Figure 27). A logarithmic regression line was fitted through the data points, yielding the following relation (R^2=0.994) between the amount of peat consolidation and the effective stress of the overlying deposits in Pa (σ'):

$$Consolidation = 17.029 ln(\sigma') - 123.9 \quad (5.1)$$

This relation was subsequently used to compute the increase in consolidation, resulting from the increased effective stress caused by the three scenarios.

Thereafter, the subsidence potential caused by land-level raising was computed for each core and each scenario. Each scenario yielded an increasing potential from the rural area towards the inner city (Figure 28). For instance, adding 1 meter of sand to the inner city and rural area resulted in a respective subsidence of 7.1 and 45.7 cm, which is equal to an increase in mean consolidation of 0.7 and 3.8% (both initial and eventual consolidation computed using equation 5.1), respectively.

Additionally, each subsequent scenario yielded a potential approximately twice as large, for a doubled effective stress increase (Figure 28). For instance; the subsidence potential of the rural area increased from 12.4 to 24.1 to 45.7 cm, and the expected subsidence for the inner city increased from 1.8 to 3.4 to 7.1 cm for scenario 1, 2 and 3, respectively.

Table 5 Calculated expected subsidence for each core location, in case the same state of consolidation (same added load) will be reached as in the inner city (B002). Additionally, the calculated initial peat thickness (h_0; calculated using equation 4.4), current peat thickness (h_1), peat thickness after maximum consolidation, average consolidation (Mean Cons), and difference in current and maximum (B002) consolidation (ΔCons) are presented for each core.

Sub-region	Core	h_0 [m]	h_1* [m]	h_2 [m]	Mean Cons [%]	ΔCons** [%]	Expected consolidation [m]
Inner city	B002	9.2	3.7	3.7	57.9	0	0
Korte Akkeren	B007	9.5	4.7	3.9	48.3	9.6	0.9
	B009	9.5	4.9	3.4	44.8	13.1	1.2
Rural	B012	12.0	7.9	4.3	28.4	29.4	3.5

* excluding the Vk3 lithological class (very clayey peat)

** difference between the mean consolidation degree of the core in question and core B002 (assumed maximum consolidation)

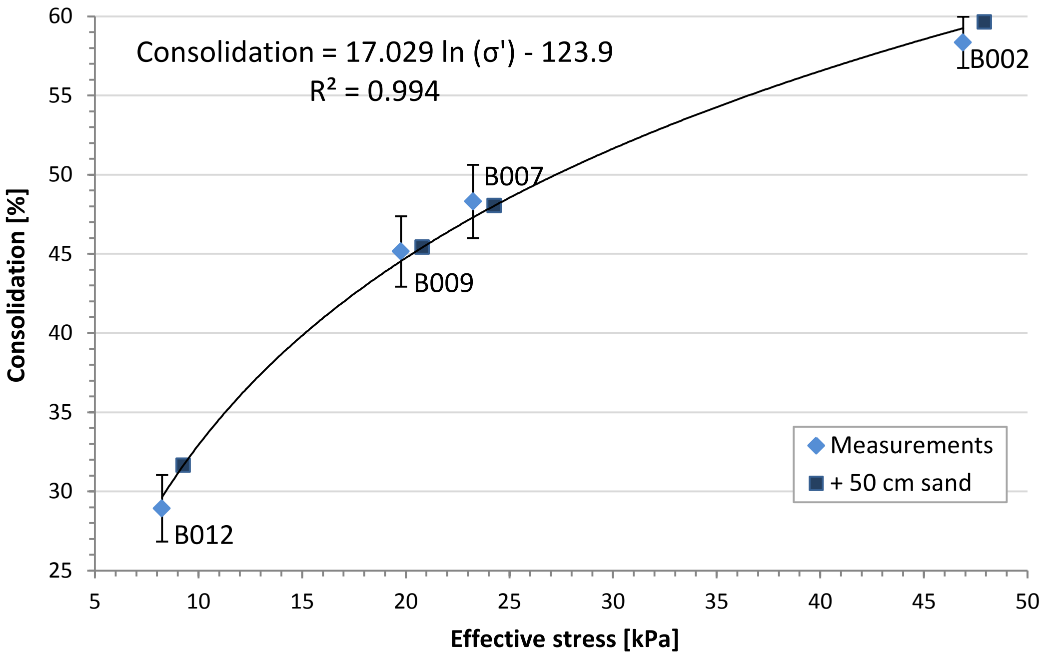

Figure 27 Graph illustrating the relation between consolidation and the amount of effective stress excreted on the peat layer by the anthropogenic layer. A logarithmic relation is plotted through the data and the corresponding relation and R^2 value are displayed. Additionally, the effect of adding an effective stress equivalent to 50 cm of sand is plotted.

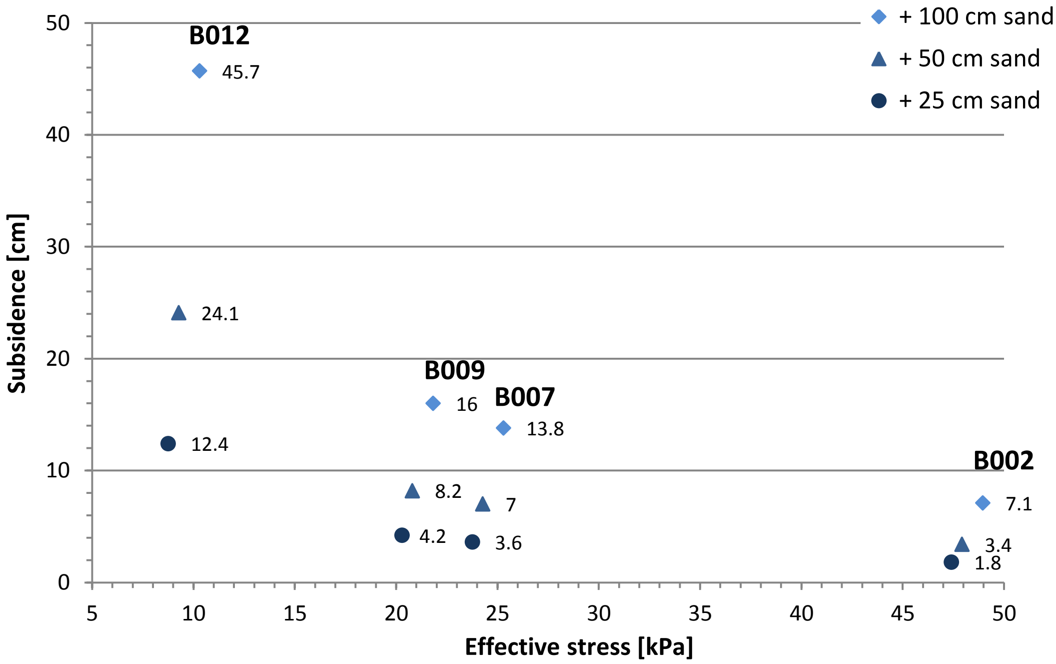

Figure 28 The calculated increase in subsidence, due adding of an additional effective stress (equivalent to 25, 50 and 100 cm of sand) on the peat layer. Calculations were executed for the four sampled core locations: B002 (inner city), B007 (eastern Korte Akkeren), B009 (central Korte Akkeren), and B012 (rural area).

6 Discussion

6.1 Subsurface architecture and its relation to subsidence

Model performance

The 3D model gives a quite good representation of the different lithostratigraphic subsurface layers. Especially the representation of the peat layer shows great detail, even incorporating a sharp drop in peat depth between Korte Akkeren and the inner city. However, improvement of the different layers is still possible, as a limited amount of cores was used.

Especially, the relatively high inaccuracy of the representation of the recent anthropogenic deposits should be tackled. The recent anthropogenic layer has a high spatial variation (varying for e.g. each street and sidewalk), while the model shows a rather smooth representation, due to the relatively low data density. Incorporating a more accurate version of the recent anthropogenic deposits would have a lot of additional value, as these deposits consist mainly of sand. Sand has a higher saturated density than the clayey sediments making up the historic anthropogenic layer (Table 2). Consequently, these recent deposits exert a large portion of the effective stress, causing a relatively large amount of the current subsidence. Development of a more realistic representation of the recent anthropogenic layer would, therefore, improve the model and the results of future modeling studies (e.g. studies on subsidence caused by loading).

This shortcoming illustrates that there is still room for improvement. Nevertheless, the final lithostratigraphic 3D model is the most accurate representation of the subsurface of Gouda to date. When the final lithostratigraphic model is compared to, for instance, the widely used GeoTop model, the amount of peat in GeoTop is overestimated by almost 60%, while the volume of anthropogenic deposits is underestimated by almost 55% (Table 3).

The newly constructed subsurface model has been improved on a couple of main points, causing the higher accuracy of the representation compared to GeoTop. 1) The resolution of the model is increased from a cell size of 100 x 100 meters to 10 x 10 meters, enabling the new model to catch local variations. 2) The use of a layer model instead of a voxel model enables a continuous depth modeling, instead of being bound to the depth intervals of the voxels. 3) Creating a model based on cross-sections increases the incorporation of geological interpretation, relative to the use of a mainly statistical model based on single cores (e.g. GeoTop; Stafleu et al., 2011). And 4) the use of faults to create sharp boundaries in layer depth between two separate regions, enabled the creation of a realistic model that does not smooth out all extreme transitions between different areas (e.g. top of the peat layer). In conclusion, the constructed 3D model is a large improvement on the representation of the subsurface of Gouda.

Differences in subsurface architecture related to subsidence history

The top elevation of the compressible peat layer differs greatly throughout the study area. However, at the end of its formation, the top of the peat would have reached approximately the same elevation everywhere, as no rivers were proximal during the last phase of peat formation (peat formation completely dependent on groundwater level). Therefore, the differences in peat depth have to be caused by differences in the amount of consolidation, which are related to the amount and duration of urban loading. In the inner city, peat is situated at the greatest depths, consistent with the aforementioned explanation, as the inner city has been subjected to urban loading the longest. Longer loading also caused a larger overburden to be exerted to the peat layer, as additional land raising was required to compensate for the continuous subsidence. The increase in anthropogenic deposits only caused additional subsidence, resulting in a vicious; hence the thick anthropogenic layer in the inner city.

In Korte Akkeren, urbanization started about 600 years later, resulting in an overall thicker peat layer and a thinner anthropogenic layer. Additionally, the top of the peat layer is situated at a greater depth in the eastern part of Korte Akkeren, as this part of the district knows largest loading (due to longer period of loading). Some exceptions on this overall pattern can be observed locally. For example, peat is situated at a larger depth in core B010 than in B009 (cross-section E; Figure 20), whilst B010 has known a shorter loading history. However, B009 is situated along a canal with relatively little loading, while B010 is situated next to some houses; evidently, the interplay between the amount and duration of loading govern the amount of subsidence, and thereby the peat depth.

In the inner city, an additional pattern within the peat elevation is observed. Peat is overall situated at a larger depth in the north than in the southeast (cross-section A; Figure 20). This pattern relates to the elevation of the fluvial deposits underlying the peat. From the northwest to the northeast, the elevation of the top of the channel belt deposits increases (Figure 21), causing less peat to be formed in the southwestern area. When less peat is present in the subsurface, less volume will be lost when loaded with the same amount as an area with a thick peat layer. This also applies to the peat in the southeastern part of the inner city compared to the northern part, resulting in a higher peat elevation in the southeast (and a thinner anthropogenic layer).

Additionally, the anthropogenic deposits situated on top of the Gouwe channel deposits are not related to any of the other patterns described. These clayey channel deposits are a lot less sensitive to subsidence, resulting in less need for land raising through time and, therefore, a relatively thin anthropogenic deposits.

6.2 Consolidation computations; accuracy and patterns

Accuracy of the computed consolidation

To get estimation on the accuracy of the calculated degree of consolidation, the average consolidation of each sampled core was compared to an estimated amount of consolidation. The estimate of the consolidation was based on the assumption that the elevation of the peat at the end of its formation would have reached the same elevation of the entire region. Erkens et al. (2016) found that fen peats in the western peat area formed up to an average level of 50 cm above NAP (including a correction for background subsidence). Assuming the peat underneath Gouda originally reached an elevation 50 cm above NAP, the original and current peat thickness could be calculated. Consequently, the resulting consolidation could be determined.

The upper peat sequence consists mainly of wood peat (Addendum 1 to 3). This makes the assumption that the peat was formed up to an elevation of about 50 cm above NAP quite acceptable, as wood peat formed around groundwater level. Additionally groundwater levels follow the relief, enabling the formation of peat above sea-level.

Table 6 indicates that the difference of the estimated and the computed average degrees of consolidation differ less than 10%. This demonstrates that the calibrated relations, found by Van Asselen (2011) (equations 4.2 to 4.4) to compute the degree of consolidation of a peat sample, are widely applicable throughout the Rhine-Meuse Delta. Additionally, the good correlation between the expected and calculated degree of consolidation, provides a good basis for the calculations of the subsidence potential.

Table 6 Estimated degree of consolidation compared to the average consolidation calculated for each sampled core. Additionally, the estimated original peat thickness ($h_{0,estimated}$), the current peat thickness (h_1) and the difference between the average consolidation and the estimated consolidation are given.

Sub-region	Core	$h_{0, estimated}$ [m]	h_1 [m]	Cons $_{estimated}$ [%]	Cons $_{average}$ [%]	Difference [%]
Inner city	B002	9.8	3.7	62.2	57.9	-8.3
Korte Akkeren	B007	9.3	4.7	49.6	48.3	-1.3
	B009	8.8	4.9	44.0	44.8	0.8
Rural area	B012	11.4	7.9	30.7	28.4	-2.3

Trends in computed consolidation with depth and varying effective stress

Three trends were observed in the obtained consolidation data for the four different locations with varying overburden (Figure 26):

1) The average consolidation increases from the rural area towards the inner city from 28.4 to 57.9%. This observation agrees with the overall decrease in peat elevation from the rural area to the inner city, as described in section 5.1. The peat underneath the inner city has been loaded for a longer period of time and with a load increasing over this time, due to land-level raising. Consequently, higher degrees of consolidation are caused by longer loading and higher effective stresses exerted on the peat. After a certain time, however, an equilibrium can develop, concluding the increase in consolidation until additional load is added. After severe loading for a long time, peat might reach a maximum stage of consolidation, making it unable to compress the peat any further.

2) For each location the consolidation decreases with depth. Normally, an increase with depth would be expected, as the effective stress also increases with depth. This behavior has not been observed before. However, it can still be explained by the extreme loads exerted due to urbanization. When an area is urbanized, the effective stress exerted on the peat is largely increased, almost instantly. This causes the effective stress to increase drastically for the upper peat (from almost nothing to quite a lot). For deeper peat, the same increase in effective stress is relatively smaller, due to the larger initial effective stress exerted by all overlaying deposits. The relatively large increase in effective stress for the upper deposits will cause these deposits to be compressed more than the lower part of the peat.

Alternately, this decrease with depth could be caused by the geological sequence, as the peat is deposited on top of Holocene clay deposits which have a low permeability. Therefore, water might only be expulsed very slowly from the deep peat, which would result in slow consolidation at the bottom of the peat layer. However, in the top layer, water could more easily be expulsed upwards, resulting in faster consolidation.

A last explanation for the decrease in consolidation with increasing depth might be offered by differences in hydrostatic pressure throughout the peat layer. Which of the three explanations actually caused the decrease in consolidation is not clear yet. Although a combination of the first and second explanation (or even all three), seems quite plausible.

3) The decrease in consolidation over depth is smaller for heavily loaded peat layers than for peat experiencing a lesser load. This might be caused by the initial consolidation of the upper peat due to its relatively larger effective stress increase. After a certain time the top of the peat layer might approximate its maximum consolidation stage. Added load would no longer be absorbed by the upper peat, causing the deeper peat to consolidate more.

Alternately, areas with a thicker anthropogenic layer (larger effective stress) are loaded for a longer period of time. This might simply cause the deeper peat, which apparently consolidates slower, to have more time to consolidate. Therefore, these might reach a higher consolidation stage, decreasing the difference between the upper and lower peat.

6.3 Subsidence potential calculations; analysis and quality

Relation between subsidence potential and loading history

An approximation of the maximum subsidence potential and the potential caused by increased loading were computed in this study. Both of these methods to compute the subsidence potential indicated the expected pattern of a high subsidence potential in the rural area and a low potential in the inner city (increasing anthropogenic layer thickness). The subsidence potential caused by adding, for instance, 1 meter sand decreased from 45.7 to 7.1 cm (Figure 28). The maximum subsidence potential also showed the decreasing pattern from 3.5 m in the rural area to 0.9 m in the eastern part of Korte Akkeren (Table 5). This pattern is explained by the long history of consolidation in the inner city (thick anthropogenic layer). This simply implies that most consolidation has already taken place, while the rural area has known little consolidation, causing its subsidence potential to remain high.

The effect of adding large amounts of sand on a relatively compressible peat layer can also be observed from the InSAR data (Figure 2). For instance, at the location of core B005A (Korte Akkeren; relatively large subsidence potential compared to inner city), where a lot of sand was encountered at a recently built housing block, subsidence rates are much higher than anywhere in the neighborhood. Here, subsidence rates of 20 up to 40 mm/yr are observed, while the surrounding area encounters rates of approximately 5 mm/yr. This illustrates the spatial variability in urban loading, results in a differential subsidence pattern.

Quality of the subsidence potential calculations

For the calculation of the maximum subsidence potential, the assumption was made that the inner city had practically reached its maximum degree of consolidation. When the effect of adding an additional load to the inner city was computed, the increased consolidation indeed proved to be small. Only 7 cm of subsidence and a consolidation increase of 0.7% would be initiated by adding a load with the equivalent of 1 meter of sand. This confirms the assumption that the degree of consolidation in the inner city (core B002) has almost reached its maximum consolidation stage. Therefore, the method for the computation of the maximum subsidence potential can be validated.

However, it seems unrealistic that the maximum amount of consolidation will be reached in Korte Akkeren or the rural area, as this would acquire an effective stress equivalent to about 6 meters of anthropogenic deposits (core B002). For the inner city this load was gradually obtained over a period of approximately 750 years. While it is theoretically possible for all sampled core locations to reach the maximum degree of consolidation, it is quite implausible as well. The city of Gouda will probably have adopted a new strategy to deal with subsidence (instead of land-level raising), before the maximum consolidation is reached. Therefore, the load needed to reach the maximum consolidation will probably never be reached.

Still, the maximum subsidence potential does give an indication of the sensitivity of the sub-regions to subsidence caused by urban loading. Such an indication was not yet obtained before, making the computed maximum subsidence potential quite a useful property.

For calculation of the subsidence potential based on increased loading, a relation was derived based on the measured average consolidation and the effective stress excreted to the peat layer by the overlying anthropogenic deposits. However, this relation was based on only four data points, which might cause the relation to be bias. To test whether equation 5.1 is a good representation of the relation between effective stress and degree of consolidation, additional data by Van Asselen (in prep) was compared to the regression line fitted through the Gouda data (Figure 29). This plot shows that the regression line based on solely the data from Gouda agrees quite well with the regression line based on the combined data. A maximum difference between the two regression lines of about 3% of consolidation is indicated. Therefore, the consolidation equation derived in this study (equation 5.1) will give a proper approximation of the consolidation increase caused by additional loading.

For the calculation of the increased effective stress, changes in pore water pressure as a result of groundwater fluctuations were not included. This will have introduced an unknown error in the calculations, as a hydrological model is needed to accurately calculate the effect of land-level raising on local groundwater levels.

Additionally, computations did not incorporate a time component. This means that the calculated subsidence potentials are an estimation of the maximum subsidence, which will only be achieved after a long period of time has passed. Only part of the computed subsidence potentials will, therefore, be reached within foreseeable time.

To overcome the two shortcomings mentioned above, two recommendations are made. First of all, the lithostratigraphic 3D model should be combined with a hydrological model to overcome the problems with changing pore pressures. The MODFLOW software package should be used for this (Vermeulen et al., 2016), as it was designed for the iMOD model, which was used to generate the 3D subsurface model. Secondly, a time component should be incorporated into the subsidence calculations. This could be done by testing the saved peat samples using the Constant Rate of Strain test (CRS). Based on this test the compression index can be determined, which can be used to compute subsidence rates caused by increasing effective stress (NEN-Bjerrum method; e.g. Bakr, 2015).

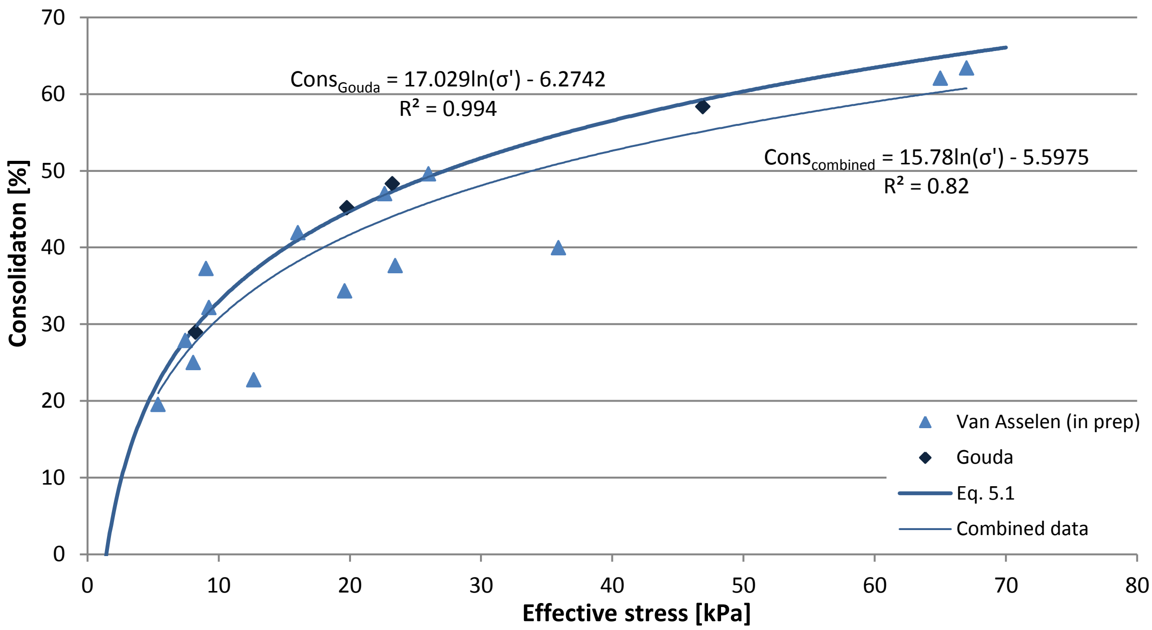

Figure 29 Average consolidation of the sample locations in Gouda and samples by van Asselen (in prep) plotted against the effective stress exerted to the peat by the layers overlying the peat layer. Both the regression line based on the Gouda data and a regression line based on both datasets combined are plotted. Both of the equations are based on σ' in kPa, instead of Pa (which is used in equation 5.1).

7 Conclusions

The aims of this study were to unravel the subsidence signal, to construct an accurate representation of the subsurface and to determine the subsidence potential of the different sub-regions within the research area. Additionally, differences in subsurface build-up and peat consolidation were analyzed based on loading history.

First of all, it can be concluded that urban loading causes the most substantial part of the observed subsidence in the city of Gouda. In the city of Gouda oxidation no longer contributes to the observed subsidence signal, as the peat layer is situated at least 65 cm below the lowest groundwater levels. In combination with literature research on the different drivers and mechanisms of subsidence, this indicated that urban loading currently accounts for circa 95% of the average subsidence rate observed in both the inner city and Korte Akkeren. The remaining subsidence is presumed to be caused by mainly tectonics, isostasy and natural consolidation.

The build-up of the different lithostratigraphic layers underneath the city of Gouda is quite complex, due to a relatively large variability in loading history. Additionally three different Holocene channel belts are present within the subsurface of Gouda, also causing a quite complex spatial variation in subsurface architecture. Consequently, it was important to generate an accurate 3D representation of the subsurface. Especially, a good representation of the peat and anthropogenic layer was required, as subsidence is mainly caused by the consolidation of the peat due to the weight exerted by the overlying anthropogenic deposits.

Comparison between the available nation-wide subsurface model of the Netherlands, "GeoTop", and the new 3D subsurface model of Gouda constructed in this study shows that GeoTop overestimates the peat volume and underestimates the volume of anthropogenic deposits by circa 60% and 55%, respectively. Additionally, patterns in the distribution of peat and anthropogenic deposits are quite unrealistic in the GeoTop model, as it is mainly based on statistics. The new subsurface model contains more geological interpretation, making it more realistic. Therefore, it can be concluded that the uses of additional local data and geological insights have greatly improved the 3D model representation of the subsurface of Gouda and thus the input for subsidence calculations.

From the subsidence calculations at four locations it is concluded that:

- The loading history has a large effect on both the current degree of consolidation and the subsidence potential. This is apparent from the fact that increased consolidation is inversely proportional with the subsidence potential in all locations. When peat becomes more consolidated over time, less consolidation is possible in the future under similar loading conditions.
- The estimated subsidence potential of the peat in case similar loading as in the inner city is applied decreases from 3.5 m in the rural area to 0.9 m in the eastern part of Korte Akkeren. The computed subsidence potential induced by additional land-level raising with, for instance, 1 meter of sand also illustrated the decrease in subsidence potential from 45.7 cm in the rural area towards 7.1 cm in the inner city.
- The thickness of the peat is inversely proportional to the thickness of the anthropogenic layer. The elevation of the top of the peat decreases with increased loading (from southwest to northeast), while the thickness of the anthropogenic deposits increases. Heavy loading in the northeastern part of the study area caused peat volumes to decrease, increasing the need for re-raising the land, which - over time - resulted in the observed pattern.

Within the inner city a second trend is observed within the top elevation of the peat. The elevation of the top of the peat increases from the north to the southeast. This is caused by an originally thinner peat layer, as the channel belt deposits below the peat are situated at a higher elevation in the southeast of the inner city. Additionally the anthropogenic layer is thinner in this region because there was less need to raise the land-level due to the relatively low amount of subsidence in the southeastern inner city. This shows that a thin initial peat layer has a lower subsidence potential than an initially thick layer.

All in all, the results acquired in this study give a first proper indication of the subsidence potential for the different sub-regions of the research area. Additionally, the connection made between the consolidation and the subsidence potential computations with the subsurface build-up enables a rough estimation of the subsidence potential for each possible location within the study area.

Moreover, when the improved 3D subsurface model is coupled to a subsidence- or groundwater model, detailed modeling studies on both differential subsidence and groundwater management are enabled. Such modeling studies can in turn contribute to the exploration of new management strategies to cope with subsidence in both Gouda and other urban areas situated on soft peaty soils.

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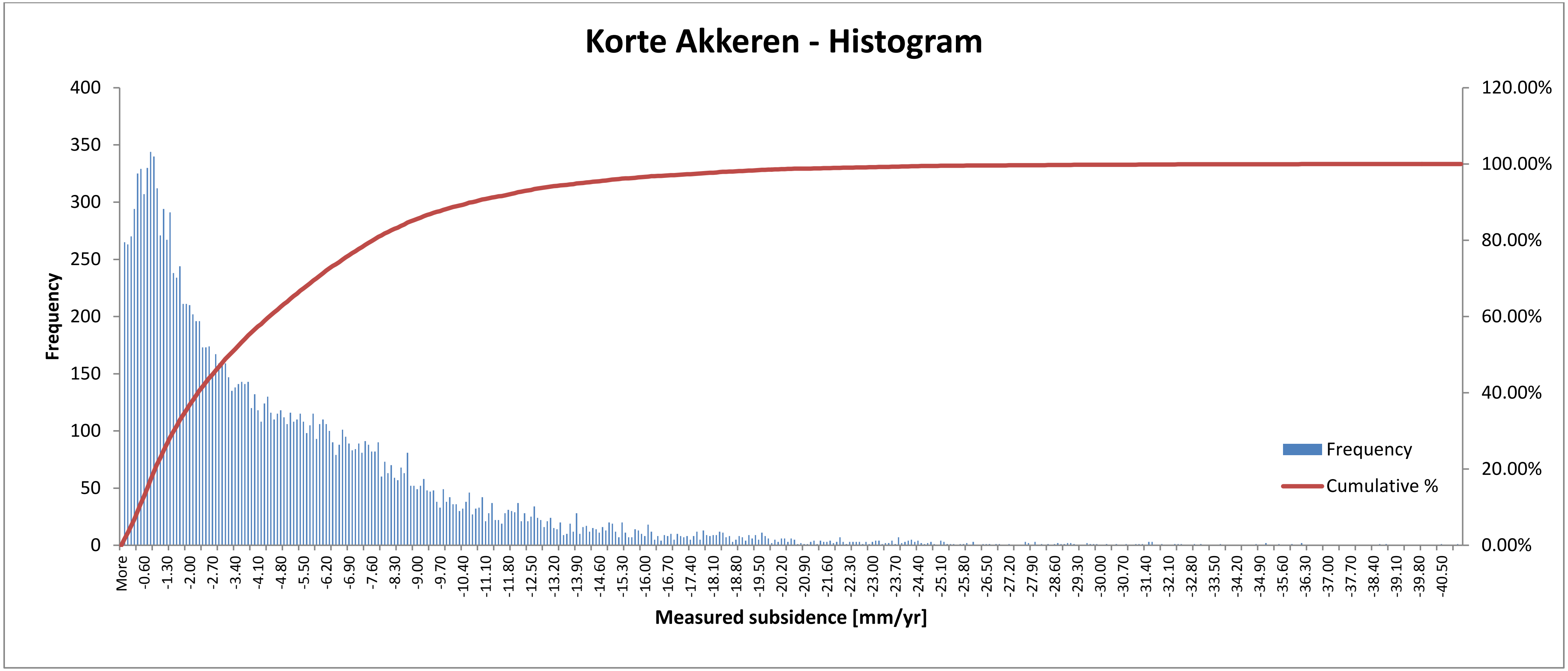
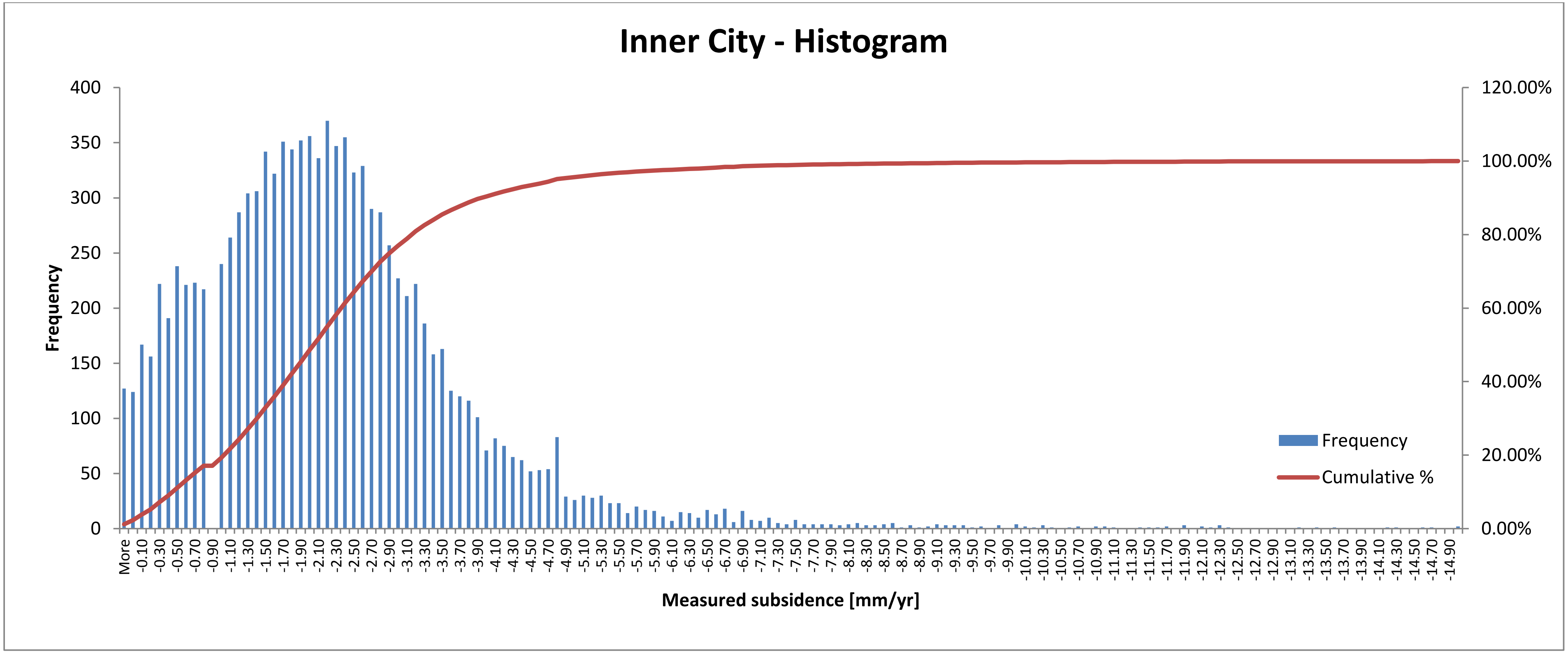
Appendices

Appendix 1: Histograms indicating the frequency of InSAR measured subsidence (measured land movement excluding positive values) for the two main sub-regions within the research area; Korte Akkeren and the Inner city.

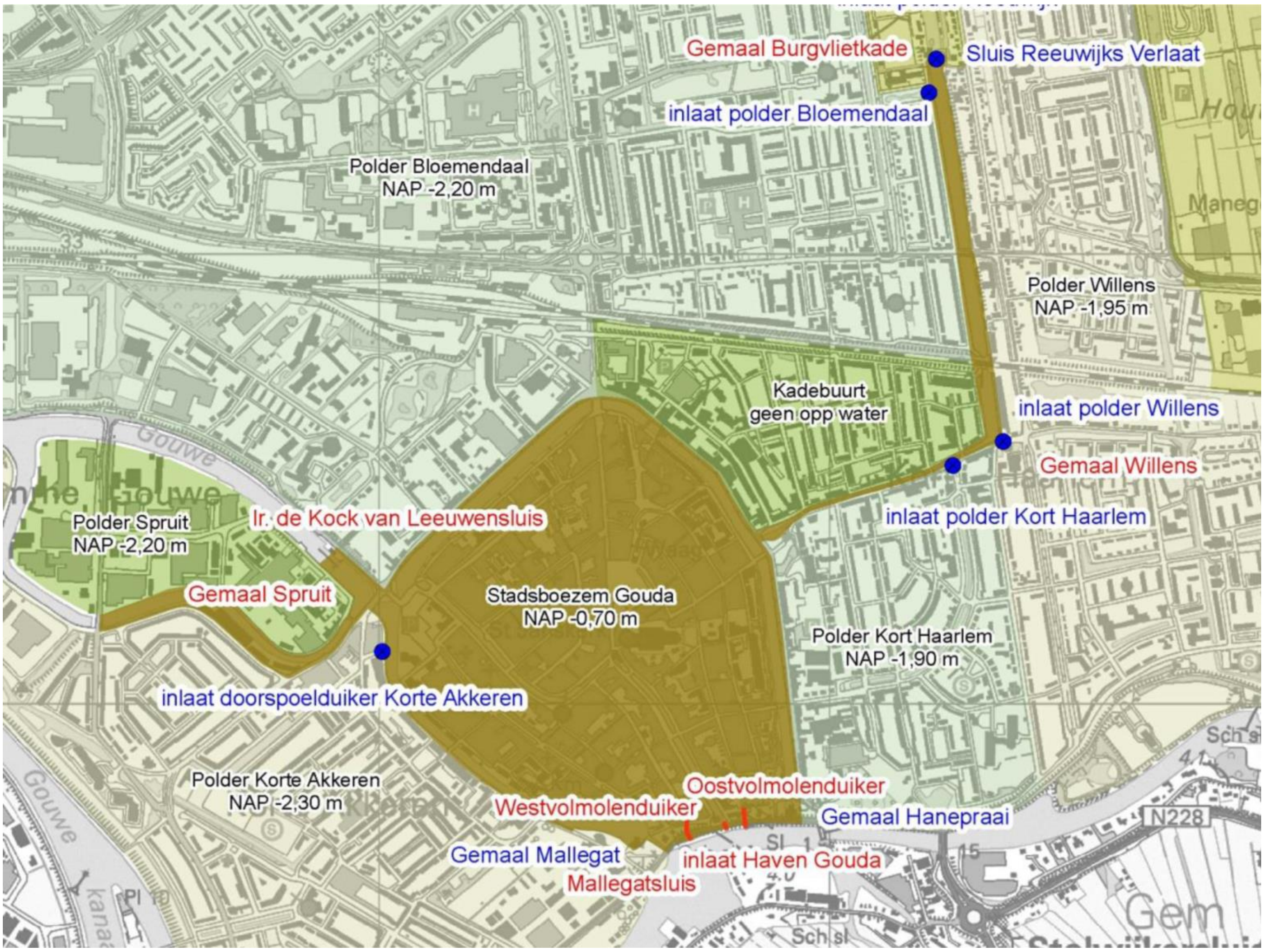


Korte Akkeren - Histogram
Frequency
Measured subsidence [mm/yr]
Frequency
Cumulative %
400
350
300
250
200
150
100
50
0
120.00%
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
More
-0.60
-1.30
-2.00
-2.70
-3.40
-4.10
-4.80
-5.50
-6.20
-6.90
-7.60
-8.30
-9.00
-9.70
-10.40
-11.10
-11.80
-12.50
-13.20
-13.90
-14.60
-15.30
-16.00
-16.70
-17.40
-18.10
-18.80
-19.50
-20.20
-20.90
-21.60
-22.30
-23.00
-23.70
-24.40
-25.10
-25.80
-26.50
-27.20
-27.90
-28.60
-29.30
-30.00
-30.70
-31.40
-32.10
-32.80
-33.50
-34.20
-34.90
-35.60
-36.30
-37.00
-37.70
-38.40
-39.10
-39.80
-40.50

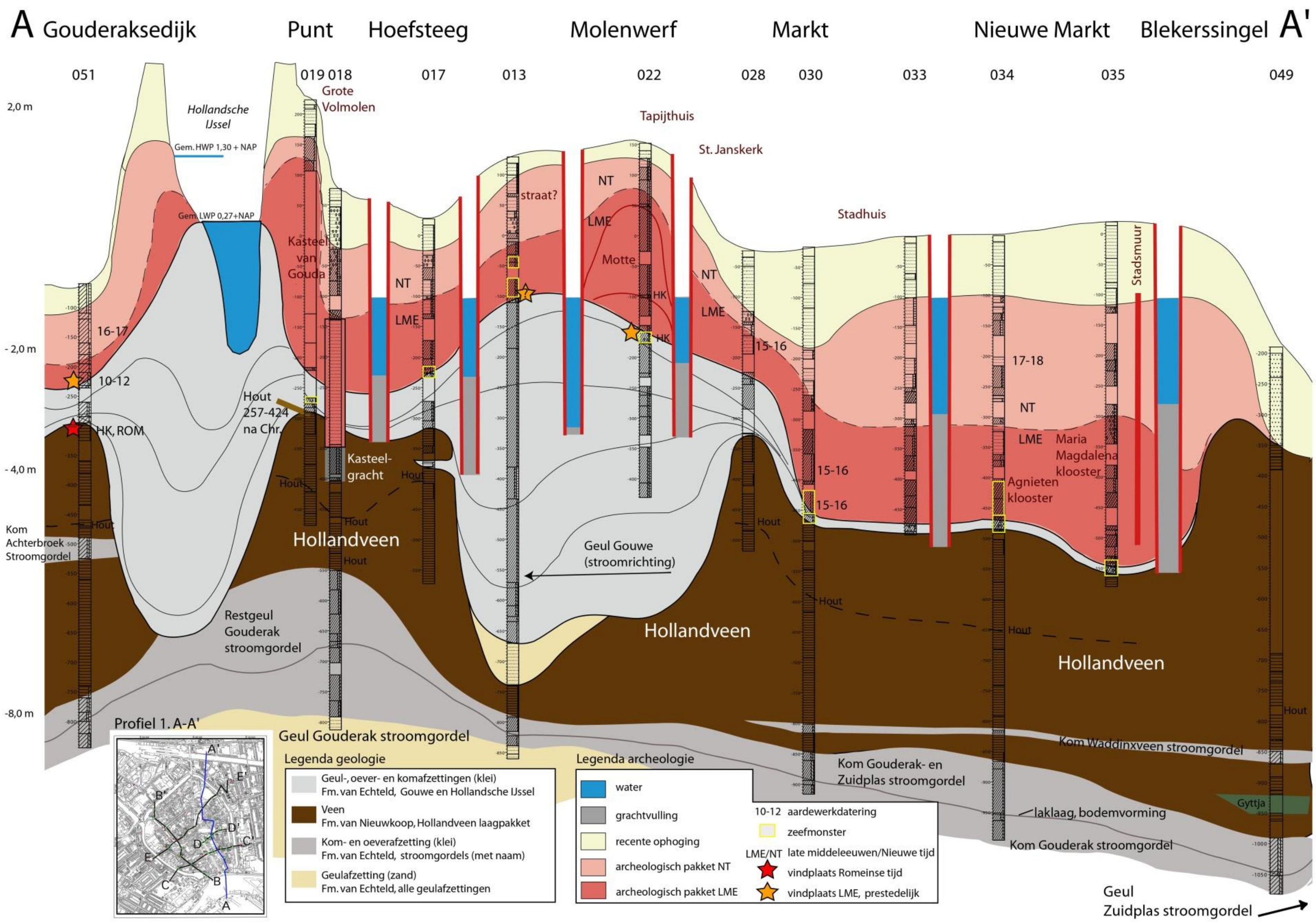


Inner City - Histogram
Frequency
Measured subsidence [mm/yr]
400
350
300
250
200
150
100
50
0
120.00%
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Frequency
Cumulative %

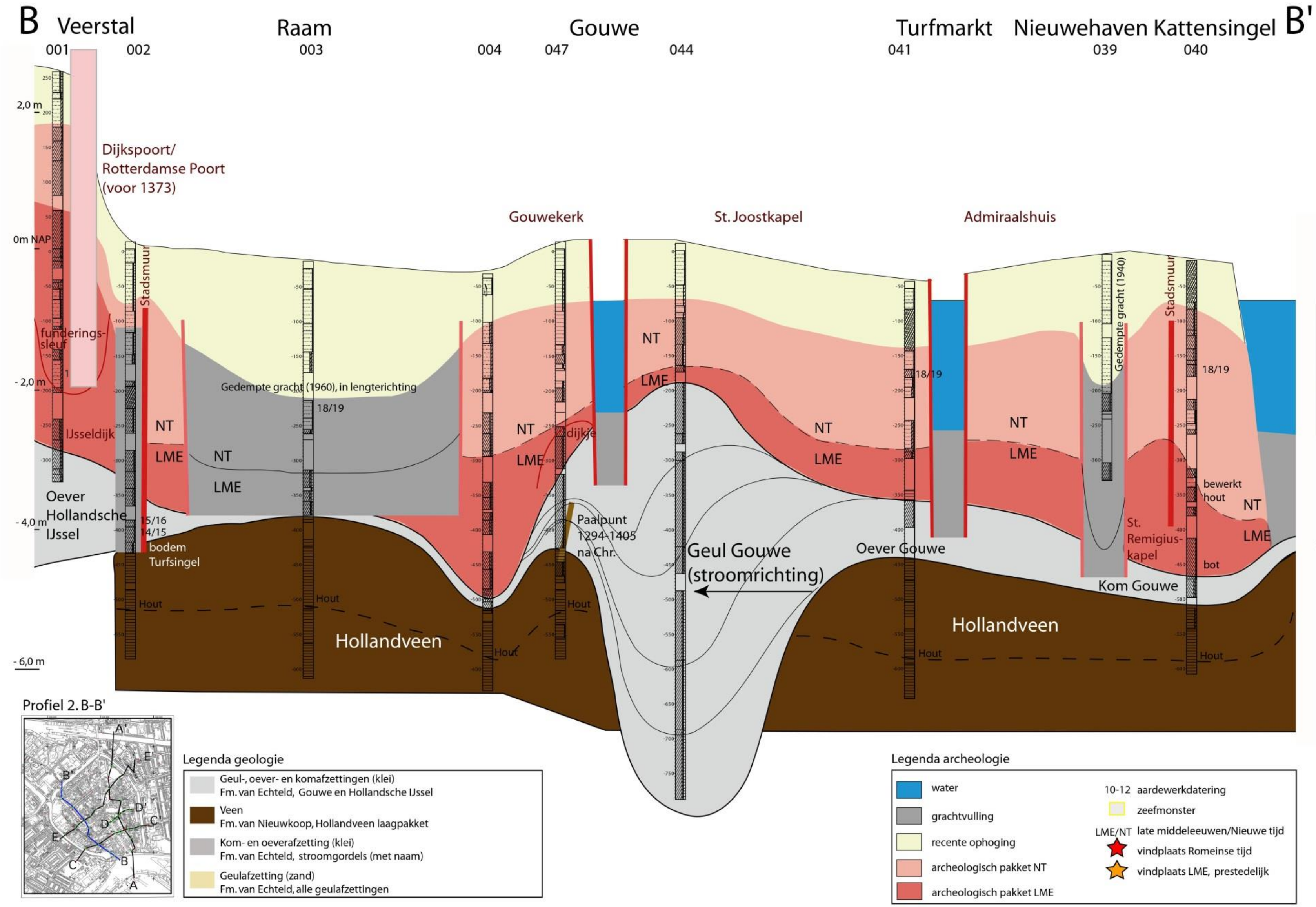
Appendix 2: pursued groundwater levels for Gouda, as determined by the water board of Rijnland. Adopted from Het Gouds Watergillde (2016).


Gemaal Burgvlietkade
Sluis Reeuwijks Verlaat
inlaat polder Bloemendaal
Polder Bloemendaal
NAP -2,20 m
Polder Willens
NAP -1,95 m
Kadebuurt
geen opp water
inlaat polder Willens
Gemaal Willens
inlaat polder Kort Haarlem
Polder Spruit
NAP -2,20 m
Ir. de Kock van Leeuwensluis
Gemaal Spruit
Stadsboezem Gouda
NAP -0,70 m
Polder Kort Haarlem
NAP -1,90 m
inlaat doorspoelduiker Korte Akkeren
Polder Korte Akkeren
NAP -2,30 m
Oostvolmolenduiker
Westvolmolenduiker
Gemaal Hanepraai
Gemaal Mallegat
inlaat Haven Gouda
Mallegatsluis
Gouwe
N228

Appendix 3: cross-sections indicating geological and archeological formations, adopted from the archeological study on the inner city of Gouda, by Van Dasselaar et al. (2013).



A Gouderaksedijk
Punt
Hoefsteeg
Molenwerf
Markt
Nieuwe Markt
Blekerssingel A'
051
019 018
017
013
022
028
030
033
034
035
049
2,0 m
- 2,0 m
- 4,0 m
-8,0 m
Hollandsche IJssel
Gem. HWP 1,30 + NAP
Gem. LWP 0,27+NAP
Grote Volmolen
Kasteel van Gouda
Tapijthuis
St. Janskerk
Stadhuis
Stadsmuur
straat?
NT
LME
Motte
HK
16-17
10-12
HK, ROM
Hout 257-424 na Chr.
Kasteelgracht
Hout
15-16
17-18
Maria Magdalena klooster
Agnieten klooster
Kom Achterbroek Stroomgordel
Hollandveen
Geul Gouwe (stroomrichting)
Restgeul Gouderak stroomgordel
Profiel 1. A-A'
Geul Gouderak stroomgordel
Kom Waddinxveen stroomgordel
Kom Gouderak- en Zuidplas stroomgordel
laklaag, bodemvorming
Gyttja
Kom Gouderak stroomgordel
Geul Zuidplas stroomgordel
Legenda geologie
Geul-, oever- en komafzettingen (klei) Fm. van Echteld, Gouwe en Hollandsche IJssel
Veen Fm. van Nieuwkoop, Hollandveen laagpakket
Kom- en oeverafzetting (klei) Fm. van Echteld, stroomgordels (met naam)
Geulafzetting (zand) Fm. van Echteld, alle geulafzettingen
Legenda archeologie
water
grachtvulling
recente ophoging
archeologisch pakket NT
archeologisch pakket LME
10-12 aardewerkdatering
zeefmonster
LME/NT late middeleeuwen/Nieuwe tijd
vindplaats Romeinse tijd
vindplaats LME, prestedelijk

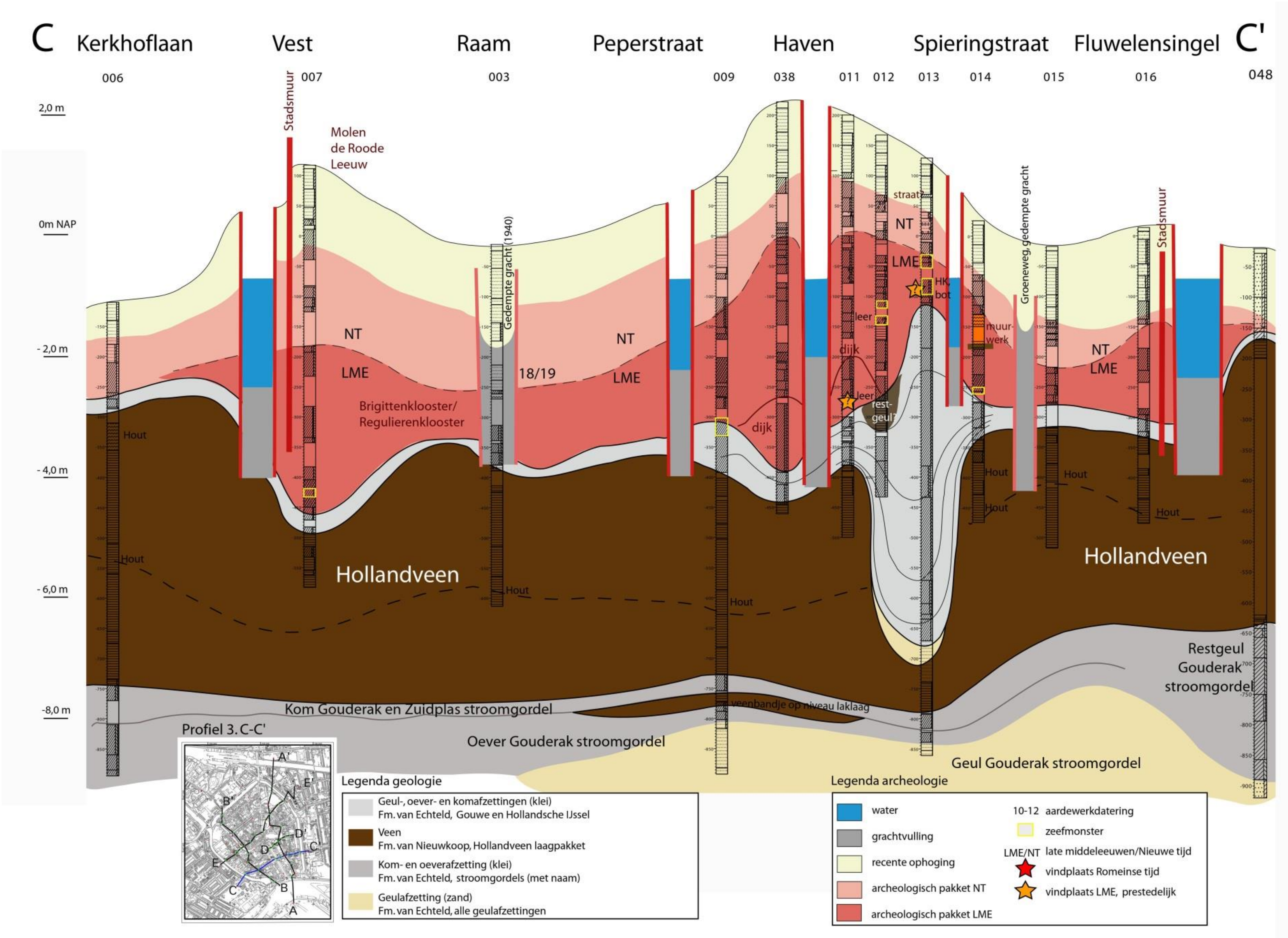


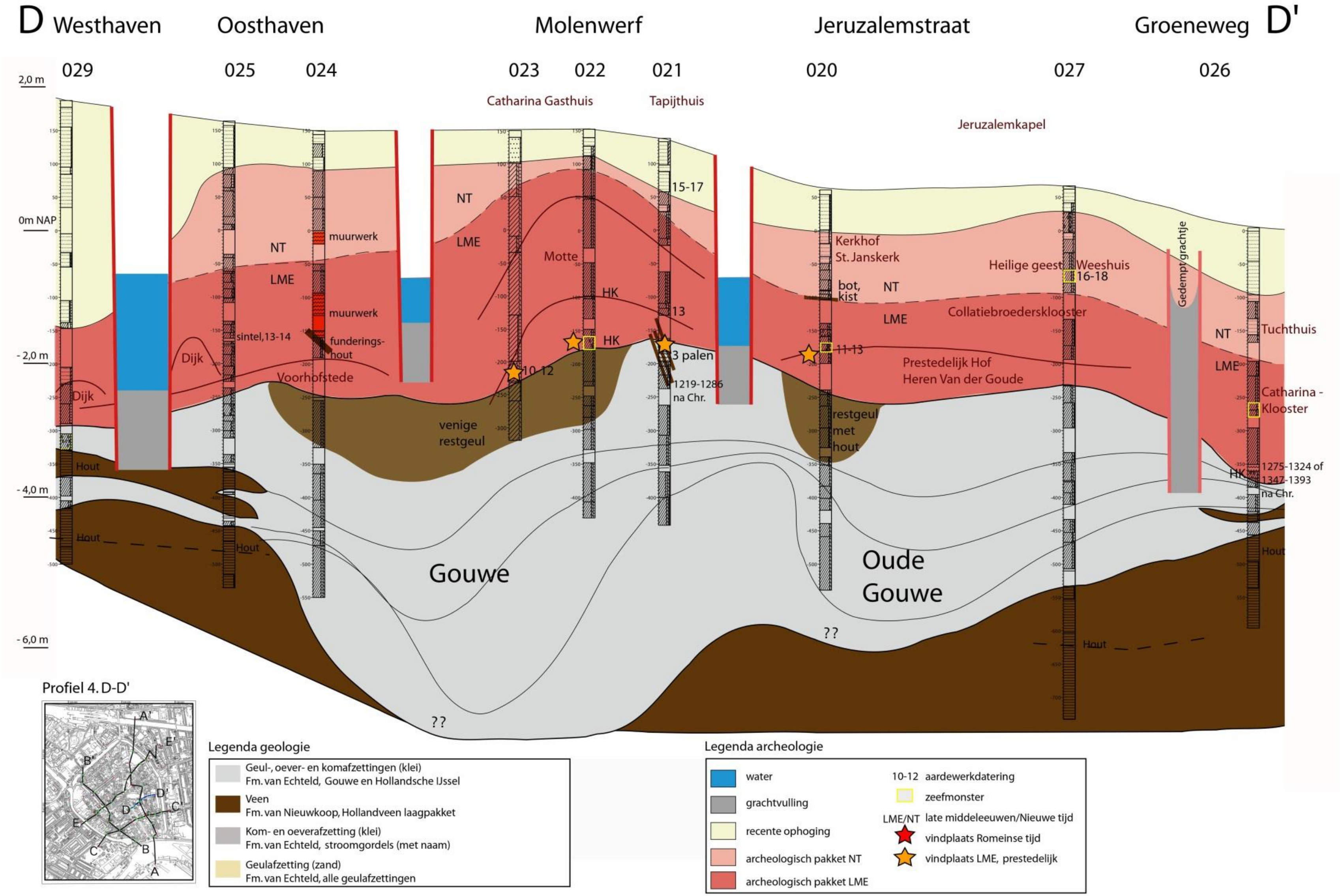
Legenda geologie

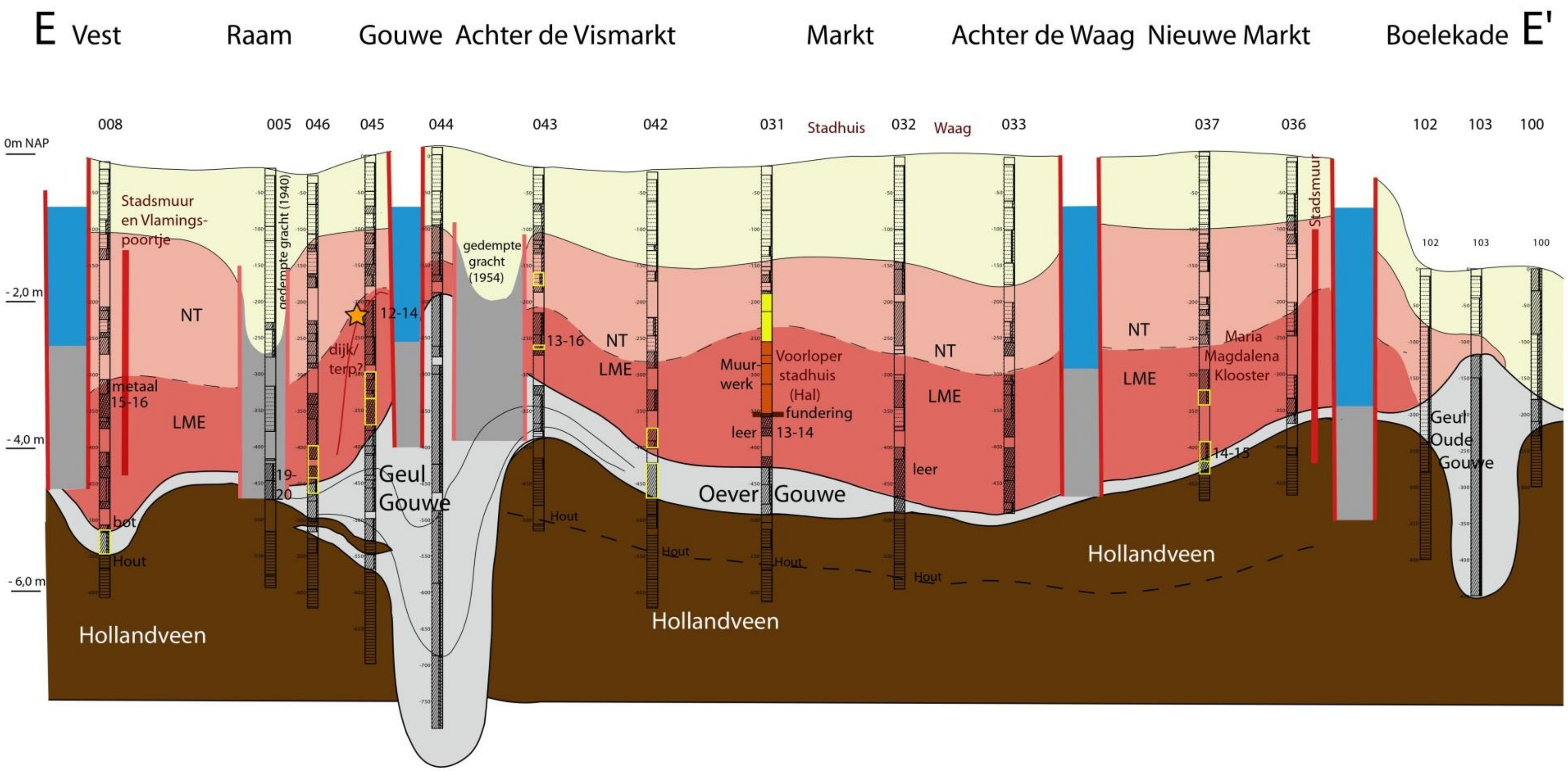
- Geul-, oever- en komafzettingen (klei) Fm. van Echteld, Gouwe en Hollandsche IJssel
- Veen Fm. van Nieuwkoop, Hollandveen laagpakket
- Kom- en oeverafzetting (klei) Fm. van Echteld, stroomgordels (met naam)
- Geulafzetting (zand) Fm. van Echteld, alle geulafzettingen

Legenda archeologie

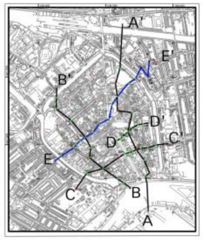
- water
- grachtvulling
- recente ophoging
- archeologisch pakket NT
- archeologisch pakket LME
- 10-12 aardewerkdatering
- zeefmonster
- LME/NT late middeleeuwen/Nieuwe tijd
- vindplaats Romeinse tijd
- vindplaats LME, prestedelijk


C
Kerkhoflaan
Vest
Raam
Peperstraat
Haven
Spieringstraat
Fluwelensingel
C'
006
007
003
009
038
011
012
013
014
015
016
048
2,0 m
0m NAP
- 2,0 m
- 4,0 m
- 6,0 m
-8,0 m
Stadsmuur
Molen de Roode Leeuw
Gedempte gracht (1940)
Groeneweg, gedempte gracht
NT
LME
18/19
Brigittenklooster/ Regulierenklooster
straat
HK bot
leer
dijk
restgeul?
muurwerk
Hout
Hollandveen
Restgeul Gouderak stroomgordel
Kom Gouderak en Zuidplas stroomgordel
veenbandje op niveau laklaag
Oever Gouderak stroomgordel
Geul Gouderak stroomgordel
Profiel 3. C-C'
Legenda geologie
Geul-, oever- en komafzettingen (klei) Fm. van Echteld, Gouwe en Hollandsche IJssel
Veen Fm. van Nieuwkoop, Hollandveen laagpakket
Kom- en oeverafzetting (klei) Fm. van Echteld, stroomgordels (met naam)
Geulafzetting (zand) Fm. van Echteld, alle geulafzettingen
Legenda archeologie
water
grachtvulling
recente ophoging
archeologisch pakket NT
archeologisch pakket LME
10-12 aardewerkdatering
zeefmonster
LME/NT late middeleeuwen/Nieuwe tijd
vindplaats Romeinse tijd
vindplaats LME, prestedelijk


D Westhaven
Oosthaven
Molenwerf
Jeruzalemstraat
Groeneweg D'
029
025
024
023
022
021
020
027
026
Catharina Gasthuis
Tapijthuis
Jeruzalemkapel
2,0 m
0m NAP
- 2,0 m
- 4,0 m
- 6,0 m
NT
LME
muurwerk
muurwerk
funderings-hout
sintel,13-14
Dijk
Dijk
Voorhofstede
Motte
HK
HK
10-12
15-17
13
3 palen
1219-1286 na Chr.
venige restgeul
Hout
Hout
Hout
Gouwe
??
Kerkhof St. Janskerk
bot, kist
11-13
Heilige geest
Weeshuis
16-18
Collatiebroedersklooster
Prestedelijk Hof Heren Van der Goude
restgeul met hout
Oude Gouwe
??
Hout
Gedempt grachtje
Tuchthuis
Catharina - Klooster
1275-1324 of 1347-1393 na Chr.
Profiel 4. D-D'
Legenda geologie
Geul-, oever- en komafzettingen (klei) Fm. van Echteld, Gouwe en Hollandsche IJssel
Veen Fm. van Nieuwkoop, Hollandveen laagpakket
Kom- en oeverafzetting (klei) Fm. van Echteld, stroomgordels (met naam)
Geulafzetting (zand) Fm. van Echteld, alle geulafzettingen
Legenda archeologie
water
grachtvulling
recente ophoging
archeologisch pakket NT
archeologisch pakket LME
10-12 aardewerkdatering
zeefmonster
LME/NT late middeleeuwen/Nieuwe tijd
vindplaats Romeinse tijd
vindplaats LME, prestedelijk



Profiel 5. E-E'



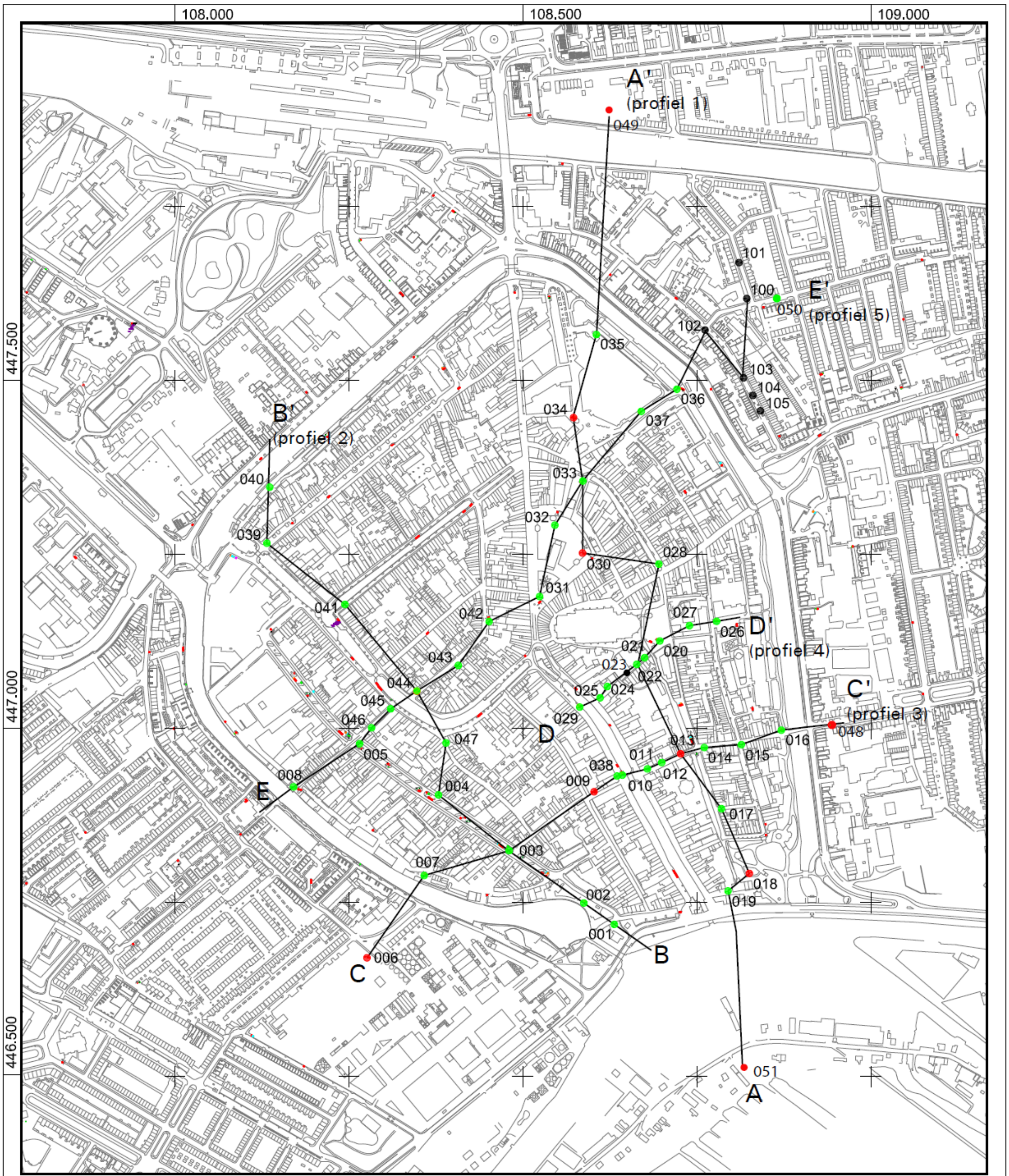
Legenda geologie

- Geul-, oever- en komafzettingen (klei) Fm. van Echteld, Gouwe en Hollandsche IJssel
- Veen Fm. van Nieuwkoop, Hollandveen laagpakket
- Kom- en oeverafzetting (klei) Fm. van Echteld, stroomgordels (met naam)
- Geulafzetting (zand) Fm. van Echteld, alle geulafzettingen

Legenda archeologie

- water
- grachtvulling
- recente ophoging
- archeologisch pakket NT
- archeologisch pakket LME
- 10-12 aardewerkdatering
- zeefmonster
- LME/NT late middeleeuwen/Nieuwe tijd
- vindplaats Romeinse tijd
- vindplaats LME, prestedelijk

Appendix 4: map indicating the core locations and cross-sections from the archeological study on the inner city of Gouda, by Van Dasselaar et al. (2013).



legenda

- boring tot 5-7 m-mv
- boring tot 8-10 m-mv
- handmatige boring tot 1-4,5 m-mv
- A A' profiellijn met naam

ArcheoMedia

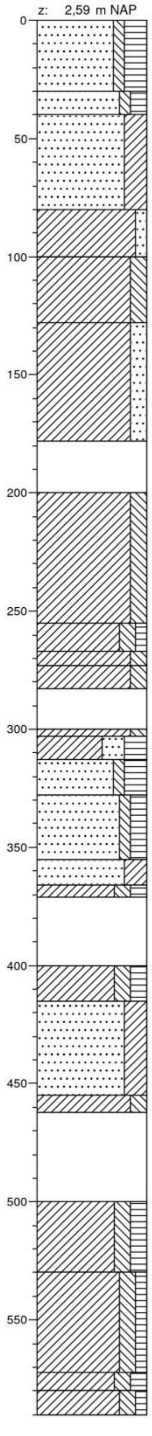
Binnenstad		Overzicht	
Gouda		Boorpunten	
Opdrachtnr.	A12-041-I	Datum	september 2012
Schaal	1:7500	Formaat	A4
Getekend	at	Bijlage	

0 m. 375

Appendix 5: core descriptions from the archeological study of the inner city, conducted by Van Dasselaar et al. (2013).

Boring: 001

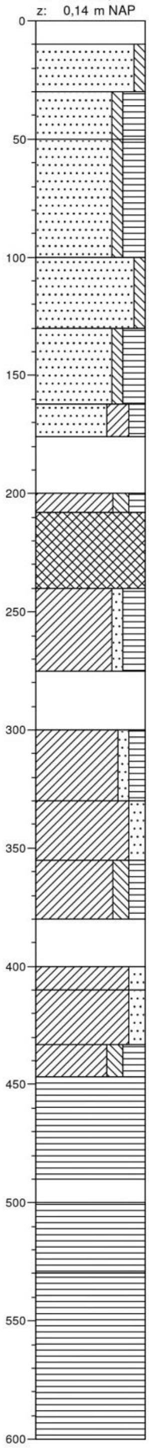
X: 108631,29
Y: 446718,73
z: 2,59 m NAP



- Zand, uiterst fijn, zwak siltig, sterk humeus, zwak puinhoudend, donker zwartgrijs, teelaarde
- Zand, uiterst fijn, zwak siltig, matig humeus, matig puinhoudend, grijsbruin
- Zand, uiterst fijn, kleiïg, sterk puinhoudend, donker grijsbruin, roodbakkend aardewerk 18/19e eeuw
- Klei, zwak zandig, matig roesthoudend, licht oranjebruin, aardewerk, pijpesteel 17e eeuw
- Klei, matig siltig, matig roesthoudend, licht bruinbruin
- Klei, matig zandig, sterk puinhoudend, bruingrijs, grof puin, dakpan, v1.1 op 1.52- mv
- Hiaat
- Klei, matig siltig, matig roesthoudend, licht oranjebruin
- Klei, matig siltig, zwak humeus, grijs, donkergrijze humeuze vlekken, nat
- Klei, matig siltig, sterk puinhoudend, grijs, groot brok baksteen
- Klei, matig siltig, bruingrijs
- Hiaat
- Klei, matig siltig, grijs
- Klei, sterk zandig, sterk humeus, zwak puinhoudend, grijsbruin
- Zand, uiterst fijn, zwak siltig, sterk humeus, uiterst puinhoudend, donker zwartgrijs, v1.2 natuursteen+ baksteenpuin
- Zand, uiterst fijn, zwak siltig, matig humeus, zwak puinhoudend, zwak schelphoudend, donker grijsgrijs, v1.3 slakkenhuis
- Zand, uiterst fijn, kleiïg, sterk puinhoudend, zwak houthoudend, donker roodgrijs
- Klei, matig siltig, matig humeus, bruingrijs, iets gelaagd/vlekkerig
- Hiaat
- Klei, matig siltig, matig humeus, bruingrijs, iets gelaagd/vlekkerig v1.4 schelp
- Zand, uiterst fijn, kleiïg, uiterst puinhoudend, zwak houthoudend, roodgrijs, v1.5 aardewerk, steenkool, ns. v1.6 hout
- Klei, matig siltig, grijs, slap
- Hiaat
- Klei, matig siltig, matig humeus, zwak wortelhoudend, grijsbruin, vlekkerig
- Klei, matig siltig, zwak humeus, bruingrijs, iets vlekkerig, kalkrijk
- Klei, matig siltig, matig humeus, donker bruingrijs, gelaagd/brokjes, donkere delen kalkloos
- Klei, matig siltig, zwak humeus, bruingrijs, iets vlekkerig, kalkrijk

Boring: 002

X: 108587,59
Y: 446749,49
z: 0,14 m NAP

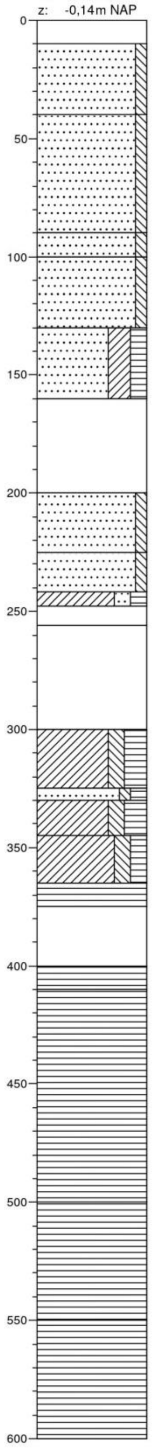


- Geel, klinkertje
- Zand, uiterst fijn, zwak siltig, geelbruin
- Zand, uiterst fijn, zwak siltig, sterk humeus, donker bruingrijs
- Zand, uiterst fijn, zwak siltig, sterk humeus, donkergrijs, houtsnippers, worteldoek
- Zand, uiterst fijn, zwak siltig, matig puinhoudend, donkergrijs, recent baksteenpuin
- Zand, matig fijn, zwak siltig, sterk humeus, donkergrijs
- Zand, uiterst fijn, kleiïg, matig humeus, sporen puin, grijs
- Hiaat
- Klei, matig siltig, matig humeus, donkergrijs, 1 dun geel zandbandje op 208 cm
- Slib, donker bruinbruin, venige cultuurlaag
- Klei, zwak zandig, sterk humeus, matig puinhoudend, donkergrijs, metaalslakken, turfbrok?
- Hiaat
- Klei, zwak zandig, matig humeus, zwak houthoudend, bruingrijs, iets vlekkerig van hout
- Klei, matig zandig, uiterst puinhoudend, roodgrijs, v2.1 leembrok uit puin
- Klei, matig siltig, matig humeus, zwak puinhoudend, zwak houthoudend, bruingrijs, klein stukje bot nog in liner
- Hiaat
- Klei, matig zandig, bruingrijs, brokjes veen/turf, v2.2 aardewerk
- Klei, matig zandig, zwak houthoudend, zwak puinhoudend, bruingrijs, v2.3 aardewerk
- Klei, matig siltig, sterk humeus, zwak schelphoudend, donker bruingrijs, grachtbodem
- Veen, mineraalarm, bruin, licht riethoudend
- Hiaat
- Veen, mineraalarm, zwak houthoudend, bruin, licht riethoudend
- Veen, mineraalarm, bruin, matig riethoudend

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 003

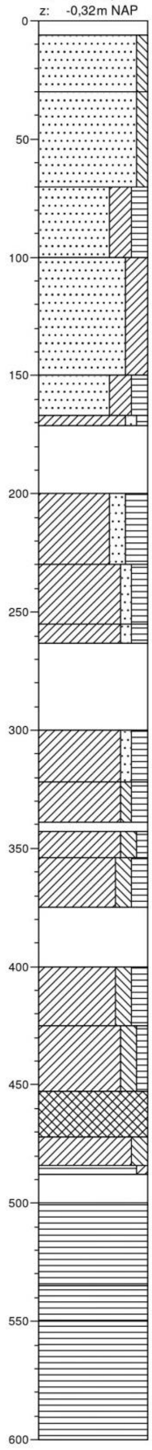
X: 108480,33
Y: 446824,12
z: -0,14m NAP



- Geel, klinker
- Zand, uiterst fijn, zwak siltig, bruingeel
- Zand, uiterst fijn, zwak siltig, grijsbruin
- Zand, uiterst fijn, zwak siltig, bruingrijs
- Zand, matig fijn, zwak siltig, grijs
- Zand, matig fijn, kleiïg, matig humeus, matig puinhoudend, grijsbruin
- Hiaat
- Zand, matig grof, zwak siltig, zwak wortelhoudend, lichtbruin, pijpesteeltje op 222 cm v3.1
- Zand, matig grof, zwak siltig, grijs
- Klei, matig zandig, matig humeus, matig puinhoudend, donkergrijs
- Hout
- Hiaat
- Klei, matig siltig, sterk humeus, matig veenhoudend, zwak houthoudend, donker zwartgrijs, grachtvulling
- Zand, uiterst fijn, zwak siltig, matig humeus, matig houthoudend, sporen baksteen, zwak schelphoudend, donkergrijs
- Klei, matig siltig, sterk humeus
- Klei, matig siltig, matig humeus, zwak veenhoudend, donkergrijs, lichtgrijze kleivlekjes
- Veen, mineraalarm, matig houthoudend, matig houtskoolhoudend, donker zwartbruin, in corecatcher v3.2
- Hiaat
- Veen, mineraalarm, donkerbruin
- Veen, mineraalarm, zwak houthoudend, bruin, enkele takken/wortels ca. 3 cm dik
- Veen, mineraalarm, bruin
- Veen, mineraalarm, zwak houthoudend, bruin, licht riethoudend

Boring: 004

X: 108378,75
Y: 446904,85
z: -0,32m NAP

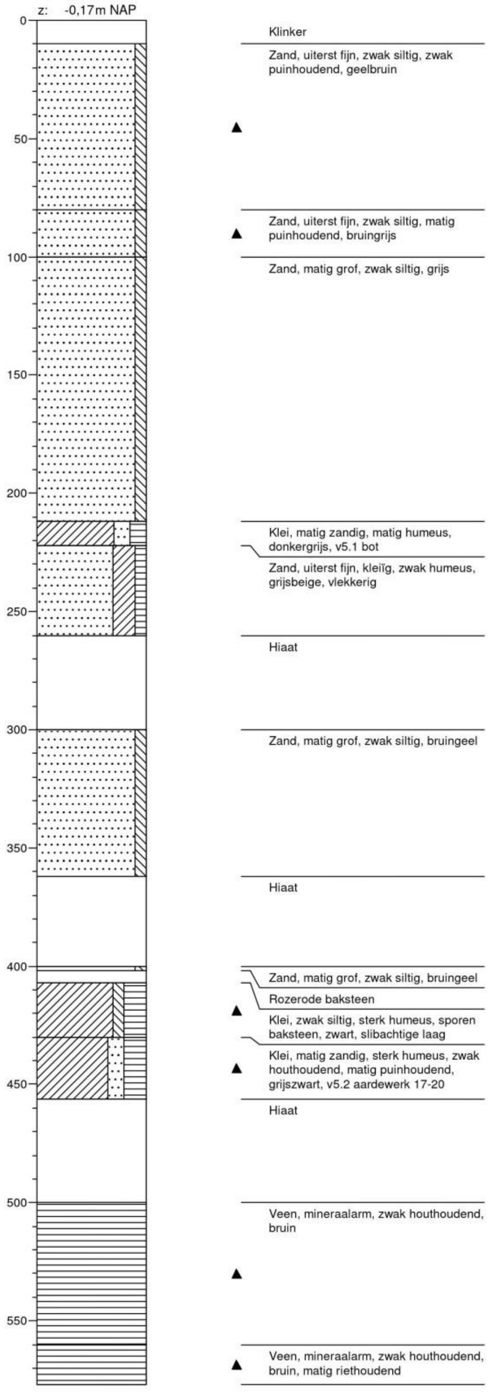


- Grijs, tegel
- Zand, uiterst fijn, zwak siltig, bruingeel
- Zand, uiterst fijn, zwak siltig, bruin
- Zand, uiterst fijn, kleiïg, matig humeus, matig puinhoudend, grijs
- Zand, matig grof, kleiïg, sporen puin, bruingeel
- Zand, uiterst fijn, kleiïg, matig humeus, matig puinhoudend, donkergrijs, slak/sintels v4.1 leer
- Klei, zwak zandig, zwak humeus, blauwgrijs
- Hiaat
- Klei, matig zandig, sterk humeus, matig puinhoudend, donker bruingrijs, laagjes zand + humeuze klei
- Klei, zwak zandig, matig humeus, sporen baksteen, zwak schelphoudend, grijs
- Klei, zwak zandig, matig humeus, zwak puinhoudend, zwak schelphoudend, donker grijsgrijs, hout/veenbrokjes
- Hiaat
- Klei, zwak zandig, matig humeus, zwak puinhoudend, zwak schelphoudend, donker grijsgrijs
- Klei, zwak siltig, matig humeus, matig houthoudend, matig veenhoudend, zwak puinhoudend, matig houtskoolhoudend, donker bruingrijs, mestige afvallaag, v4.2 leer coproliet
- Geelrood, baksteen
- Klei, matig siltig, zwak humeus, grijs, vlekkerig, veen/houtbrokjes
- Klei, matig siltig, matig humeus, zwak houtskoolhoudend, matig schelphoudend, donkergrijs, licht vlekkerig
- Hiaat
- Klei, matig siltig, matig humeus, matig veenhoudend, zwak houthoudend, zwak puinhoudend, donker bruingrijs, v4.3 bot op 425 cm
- Klei, matig siltig, zwak humeus, zwak houthoudend, donker grijsgrijs, iets gelaagd kalkrijke kleibrok/laagjes
- Slib, groenbruin, sterk gelaagd plantaardig pakket mest/riet
- Klei, matig siltig, matig veenhoudend, zwak houthoudend, bruingrijs, kalkloos
- Veen, zwak kleiïg, donker bruinbruin
- Hiaat
- Veen, mineraalarm, zwak houthoudend, bruin
- Veen, mineraalarm, matig houthoudend, donker bruinbruin
- Veen, mineraalarm, zwak houthoudend, bruin

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 005

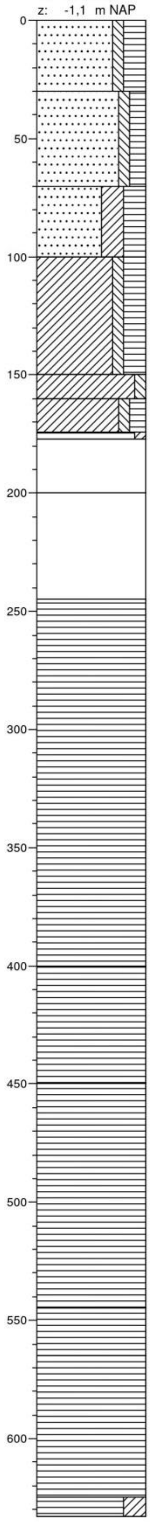
X: 108265,59
Y: 446978,49
z: -0,17m NAP



Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 006 - 1

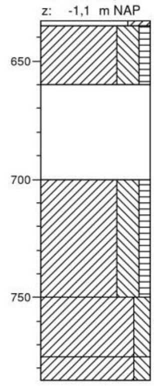
X: 108276,12
Y: 446670,77
z: -1,1 m NAP



- Zand, uiterst fijn, zwak siltig, sterk humeus, matig teelaardehoudend, grijsbruin
- Zand, uiterst fijn, zwak siltig, matig humeus, sterk teelaardehoudend, zwak puinhoudend, grijsbruin
- Zand, uiterst fijn, kleiïg, sterk humeus, donker zwartgrijs
- Klei, zwak siltig, sterk humeus, matig teelaardehoudend, sporen baksteen, donker grijsbruin, spijker op 1.34
- Klei, zwak siltig, matig veenhoudend, zwak zandhoudend, grijsbruin, geleidelijke grenzen
- Klei, zwak siltig, matig humeus, bruingrijs, komklei
- Veen, zwak kleiïg, bruin
- Hiaat
- Lichtbruin, volledig hout, boomstam
- Veen, mineraalarm, zwak houthoudend, bruin
- Veen, mineraalarm, matig houthoudend, bruin
- Veen, mineraalarm, zwak houthoudend, bruin, licht riethoudend
- Veen, mineraalarm, donker bruinbruin, matig riethoudend
- Veen, mineraalarm, zwak houthoudend, bruin, licht riethoudend
- Veen, sterk kleiïg, grijsbruin

Boring: 006 - 2

X: 108276,12
Y: 446670,77
z: -1,1 m NAP

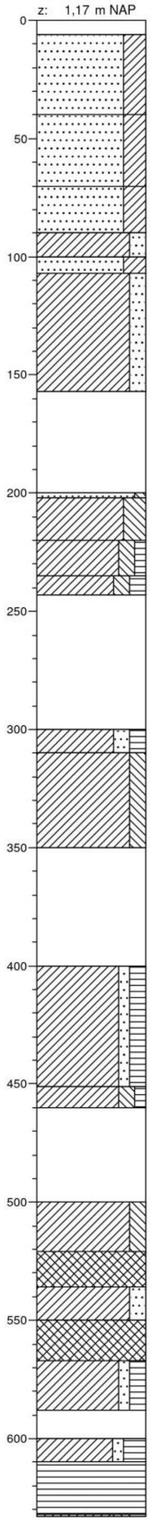


- Veen, sterk kleiïg, grijsbruin
- Klei, sterk siltig, zwak humeus, grijs, enkele humusvlekjes
- Hiaat
- Klei, sterk siltig, zwak humeus, grijs, enkele humusvlekjes, veen in top is ingevallen
- Klei, matig siltig, bruingrijs
- Klei, matig siltig, matig veenhoudend, bruingrijs, verspoelde veenbrokjes

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 007 - 1

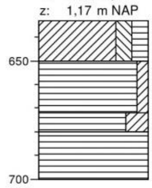
X: 108358,26
Y: 446789,43
z: 1,17 m NAP



- Grijs, tegel, 1 m uit stadsmuur
- Zand, uiterst fijn, kleïïg, bruingrijs, cementbrokje, vlekkerig
- ▲ Zand, uiterst fijn, kleïïg, zwak puinhoudend, grijsbruin, rood en geel baksteenpuin
- ▲ Zand, uiterst fijn, kleïïg, matig schelphoudend, sterk puinhoudend, grijsbruin, pijpenpot, cement, rode baksteen
- ▲ Klei, matig zandig, zwak houtskoolhoudend, grijsbruin, veenbrokjes
- ▲ Zand, uiterst fijn, kleïïg, matig roesthoudend, sporen puin, lichtbruin
- ▲ Klei, matig zandig, matig roesthoudend, sporen puin, licht beigebruin
- Hiaat
- ▲ Zand, uiterst fijn, zwak siltig, grijsbruin, v7.2 gouds groen, ingevallen?
- Klei, sterk siltig, zwak roesthoudend, zwak puinhoudend, bruingrijs, brok cement, klein roodbakkend aardewerk ongeglazuurd
- Klei, matig siltig, zwak humeus, licht grijsbruin, enkele donkere humusvlekjes
- Klei, matig siltig, matig humeus, grijs, veel donkergrijze humusvlekjes
- Hiaat
- ▲ Klei, matig zandig, matig humeus, zwak puinhoudend, grijs, cementbrokje, vlekkerig
- ▲ Klei, matig siltig, matig houthoudend, matig veenhoudend, grijsbruin, grote vlekken/ brokken klei/ veen en takken
- Hiaat
- ▲ Klei, zwak zandig, matig humeus, uiterst puinhoudend, grijs, grote brokken rood en geel baksteenpuin
- Klei, matig siltig, zwak humeus, grijs, enkel donkergrijs humusvlekje
- Hiaat
- ▲ Klei, matig siltig, zwak roesthoudend, zwak puinhoudend, licht grijsbruin
- ▲ Slib, sporen puin, bruin, venige ophoging
- ▲ Klei, matig zandig, matig puinhoudend, veel cement, V7.3 bot, gezeefd, M1
- ▲ Slib, zwak houthoudend, puin, bruin, venige ophoging
- ▲ Klei, zwak zandig, matig humeus, matig veenhoudend, sporen puin, donker bruingrijs, V7.4 baksteen
- Hiaat
- ▲ Klei, zwak zandig, sterk humeus, sterk veenhoudend, sporen puin, donker grijsbruin
- ▲ Veen, mineraalarm, zwak houthoudend, bruin
- Klei, matig siltig, matig humeus, bruingrijs, scherpe top, geleidelijke onderkant

Boring: 007 - 2

X: 108358,26
Y: 446789,43
z: 1,17 m NAP

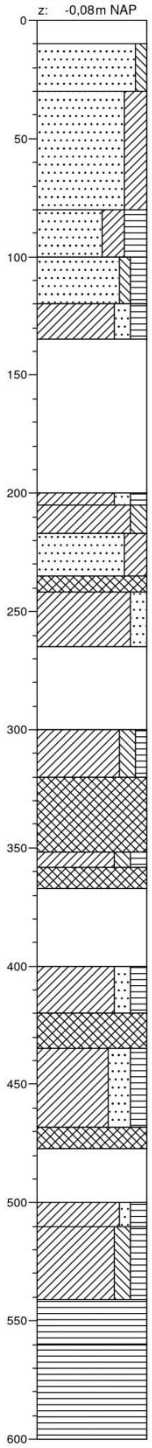


- Klei, matig siltig, matig humeus, bruingrijs, scherpe top, geleidelijke onderkant
- ▲ Veen, zwak kleïïg, zwak houthoudend, bruin
- ▲ Veen, sterk kleïïg, zwak houthoudend, bruingrijs
- ▲ Veen, mineraalarm, zwak houthoudend, bruin

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 008

X: 108170,62
Y: 446916,33
z: -0,08m NAP



Geel, klinker

Zand, uiterst fijn, zwak siltig, bruingeel

Zand, uiterst fijn, kleiïg, sterk puinhoudend, donkergrijs, pijpesteel, mortelbrokken, rode baksteen

Zand, uiterst fijn, kleiïg, sterk humeus, matig puinhoudend, donker zwartgrijs, slib, grachtvulling

Zand, zeer grof, zwak siltig, matig humeus, zwak grindhoudend, donker bruingrijs

Klei, matig zandig, matig humeus, matig puinhoudend, donker bruingrijs

Hiaat, puin?

Klei, matig zandig, matig humeus, donkergrijs

Klei, matig siltig, matig puinhoudend, bruingrijs, ijsselsteenpuin

Zand, uiterst fijn, kleiïg, matig puinhoudend, grijsbruin

Slib, zwart, venige cultuurlaag, veenbrok

Klei, matig zandig, matig puinhoudend, zwak houtskoolhoudend, bruingrijs, onderin vlekkerig

Hiaat

Klei, matig siltig, zwak humeus, grijs, venige cultuurlaag, donkergrijze humusvlekjes v8.1

Slib, donker grijsbruin, v8.2 aardewerk

Klei, matig siltig, matig humeus, donkergrijs, lichtgrijze vlekjes

Slib, matig puinhoudend, donker grijsbruin, venige cultuurlaag

Hiaat

Klei, matig zandig, matig humeus, sterk puinhoudend, donkergrijs

Slib, matig houthoudend, zwak puinhoudend, donker grijsbruin, venige cultuurlaag

Klei, sterk zandig, matig humeus, zwak houtskoolhoudend, zwak puinhoudend, grijsbruin

Slib, zwak puinhoudend, zwak houthoudend, donker grijsbruin, venige cultuurlaag

Hiaat

Klei, zwak zandig, matig humeus, donker bruingrijs, v8.3 bot

Klei, matig siltig, matig humeus, matig veenhoudend, zwak houthoudend, sporen baksteen, donker bruingrijs, grijze kalkrijke kleivlekken, zeven?

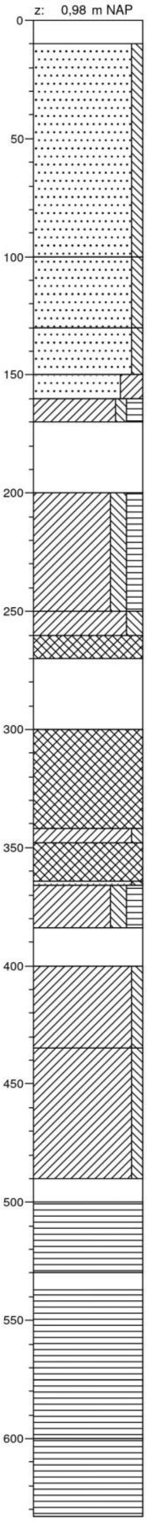
Veen, mineraalarm, matig houthoudend, donkerbruin

Veen, mineraalarm, bruin

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 009 - 1

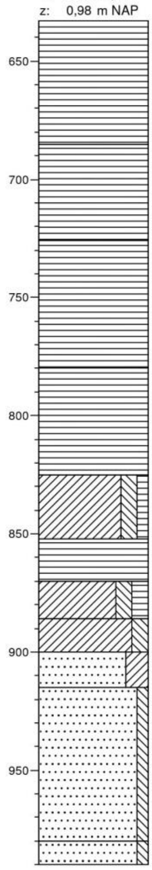
X: 108602,26
Y: 446909,31
z: 0,98 m NAP



- Paars, Klinker
- Zand, uiterst fijn, zwak siltig, bruingeel, ophoogzand
- Zand, uiterst fijn, zwak siltig, matig puinhoudend, bruingeel, Tot 130 cm voorgeboord
- Zand, uiterst fijn, zwak siltig, sterk puinhoudend, matig roesthoudend, licht oranjebruin
- Zand, uiterst fijn, kleiïg, matig puinhoudend, licht grijsgrijs, brok natuursteen, cement
- Klei, zwak siltig, matig humeus, zwak puinhoudend, donker grijsgrijs
- Hiaat
- Klei, matig siltig, matig humeus, donker grijsgrijs, kleibrokken, onderin dun puinlaagje
- Klei, matig siltig, grijsbruin
- Slib, sporen baksteen, zwart, venige ophoging
- Hiaat
- Slib, zwak houthoudend, sporen puin, zwart, venige ophoging
- Klei, zwak siltig, grijsbruin, kleibrok
- Slib, zwak houthoudend, sporen puin, zwart, venige ophoging
- Zand, uiterst fijn, zwak siltig, licht bruingrijs, aslaagje?
- Klei, matig siltig, matig humeus, matig veenhoudend, donker grijsgrijs, klei/veenbrokken
- Hiaat
- Klei, zwak siltig, sterk veenhoudend, sporen baksteen, grijsbruin, vlekkerig, veenbrokjes 1 pakket met boven
- Klei, zwak siltig, matig veenhoudend, donker bruingrijs, kleibrokjes/graafgangen zeven?
- Hiaat
- Veen, mineraalarm, bruin, lichtgrijs kleispoortje, puinspikkeltje?
- Fijne takjes? in elkaar gedrukt? v9.1
- Veen, mineraalarm, zwak houthoudend, bruin
- Veen, mineraalarm, sterk houthoudend, bruinrood
- Veen, mineraalarm, zwak houthoudend, bruin

Boring: 009 - 2

X: 108602,26
Y: 446909,31
z: 0,98 m NAP

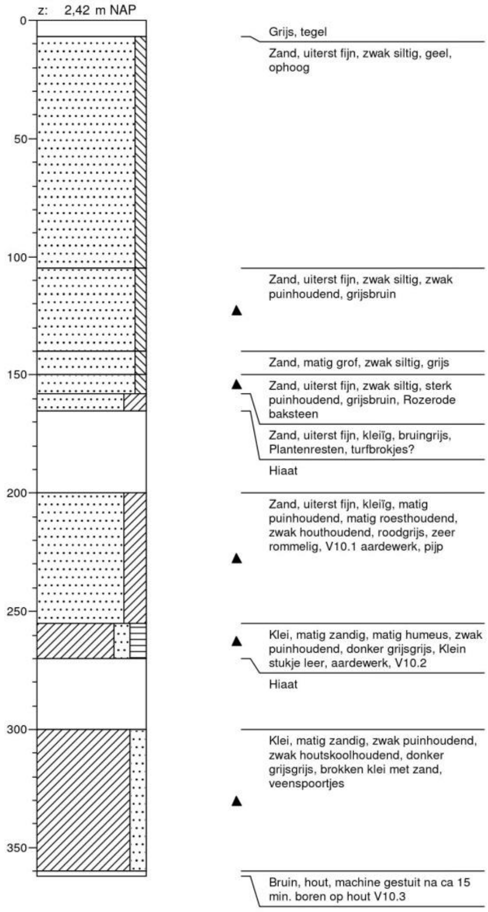


- Veen, mineraalarm, zwak houthoudend, bruin
- Veen, mineraalarm, matig houthoudend, bruin
- Veen, mineraalarm, zwak houthoudend
- Veen, mineraalarm, zwak houthoudend, bruin, licht riethoudend
- Klei, matig siltig, zwak humeus, zwak houthoudend, zwak veenhoudend, bruingrijs, top vrij scherp, ondergrens zeer geleidelijk
- Veen, mineraalarm, matig houthoudend, donker bruinbruin, geleidelijke ondergrens
- Klei, matig siltig, matig humeus, donkergrijs, laklaag
- Klei, matig siltig, grijs
- Zand, matig grof, kleiïg, grijs
- Zand, matig grof, zwak siltig, grijs, enkel humusvlekje
- Zand, uiterst fijn, zwak siltig, zwak roesthoudend, oranjegrijs

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 010

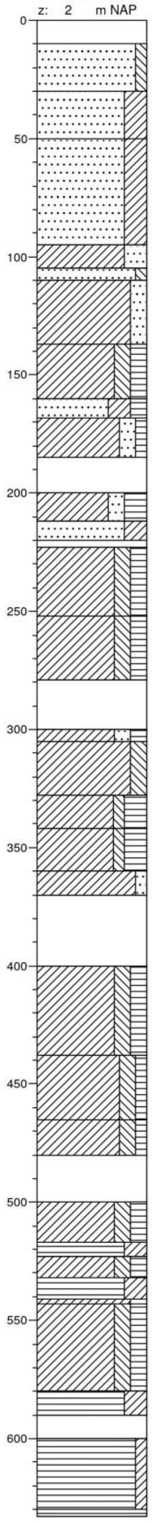
X: 108642,95
Y: 446933,27
z: 2,42 m NAP



Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 011 - 1

X: 108678,97
Y: 446942,17
z: 2 m NAP



Geel, klinker

Zand, uiterst fijn, zwak siltig, grijsbruin

Zand, uiterst fijn, kleiïg, zwak puinhoudend, rode baksteenbrokjes

Zand, uiterst fijn, kleiïg, sterk puinhoudend, grijs, rood baksteenpuin

Klei, sterk zandig, zwak roesthoudend, lichtgrijs, oranje roestvlekjes

Zand, uiterst fijn, zwak siltig, lichtbruin, in liner

Klei, matig zandig, zwak roesthoudend, bruingrijs

Klei, matig siltig, matig humeus, grijs, kleine humusvlekjes

Zand, uiterst fijn, kleiïg, matig humeus, zwak grindhoudend, zwak puinhoudend, donkergrijs, wegniveautje?

Klei, matig zandig, zwak humeus, grijsgrijs, kleibrokken met zand

Hiaat

Klei, matig zandig, sterk humeus, donker zwartgrijs, enkele lichte kleivlekken

Zand, uiterst fijn, kleiïg, zwak roesthoudend, bruingrijs

Donkerbruin, houtresten

Klei, matig siltig, matig humeus, grijsbruin

Klei, matig siltig, matig humeus, zwak veenhoudend, zwak plantenhoudend, zwak houtskoolhoudend, grijsbruin

Hiaat

Klei, matig zandig, matig humeus, zwak puinhoudend, donkergrijs

Klei, matig siltig, zwak veenhoudend, zwak plantenhoudend, grijs, hout/turfspikkels

Klei, zwak siltig, sterk humeus, sterk veenhoudend, donker bruingrijs, v11.1 leer

Klei, zwak siltig, sterk humeus, matig houthoudend, donkergrijs

Klei, zwak zandig, grijs

Hiaat

Klei, matig siltig, matig humeus, grijsbruin, lichtgrijze vlekjes, enkele houtjes

Klei, matig siltig, zwak humeus, grijs, zwarte humusvlekjes

Klei, matig siltig, zwak humeus, bruingrijs, brokken grijze en bruine klei, v11.2

Hiaat

Klei, matig siltig, matig humeus, matig veenhoudend, zwak plantenhoudend, donkerbruin

Veen, sterk kleiïg, bruinbruin, plag?

Klei, matig siltig, matig humeus, matig veenhoudend, zwak plantenhoudend, donkerbruin

Veen, sterk kleiïg, grijsbruin, licht kleivlekje, plag?

Klei, matig zandig, zwak houthoudend, zwak schelphoudend, bruingrijs, plag??

Klei, matig siltig, matig humeus, grijsbruin, natuurlijke klei

Veen, sterk kleiïg, grijsbruin, geleidelijke overgang

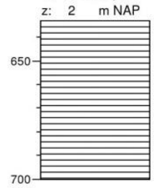
Hiaat

Veen, zwak kleiïg, matig houthoudend, donker bruinbruin, zeergeleidelijk wat kleiiger

Veen, mineraalarm, zwak houthoudend, bruin, flink stuk hout op 678 cm

Boring: 011 - 2

X: 108678,97
Y: 446942,17
z: 2 m NAP

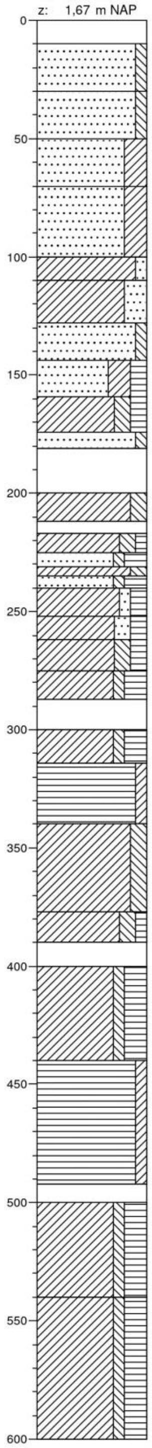


Veen, mineraalarm, zwak houthoudend, bruin, flink stuk hout op 678 cm

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 012

X: 108699,48
Y: 446951,31
z: 1,67 m NAP



Paars, klinker

Zand, uiterst fijn, zwak siltig, bruingeel

Zand, uiterst fijn, zwak siltig, zwak puinhoudend, grijsbruin, vondst steengoed

Zand, uiterst fijn, kleiïg, zwak puinhoudend, grijsbruin

Zand, uiterst fijn, kleiïg, grijsbruin

Klei, zwak zandig, grijs, in liner

Klei, sterk zandig, matig puinhoudend, zwak houtskoolhoudend, matig schelphoudend, grijsbruin, nat, rommelig

Zand, matig grof, zwak siltig, grijs

Zand, uiterst fijn, kleiïg, matig humeus, sterk puinhoudend, donkergrijs, puinlaag roze baksteen en cement

Klei, matig siltig, matig humeus, zwak veenhoudend, zwak houthoudend, donker grijsgrijs, zwarte humeuze vlekken

Zand, uiterst fijn, zwak siltig, donkergrijs, baksteenfragmentjes

Hiaat

Klei, matig siltig, zwak roesthoudend, bruingrijs

Matig veenhoudend, zwak houthoudend, donkerbruin, venig ophooglaag/ loopniveau

Klei, matig siltig, zwak humeus, grijs, kleiplag?

Zand, matig grof, zwak siltig, sterk humeus, donkergrijs

Klei, matig siltig, grijs

Zand, uiterst fijn, zwak siltig, sterk humeus, donkergrijs

Klei, zwak zandig, matig humeus, matig veenhoudend, zwak houthoudend, donker bruingrijs, gelaagd ophoogpakket

Klei, matig zandig, matig humeus, donker bruingrijs, baksteen? aardewerkspikkel

Klei, matig siltig, matig humeus, grijsbruin

Klei, zwak siltig, sterk humeus, sterk veenhoudend, matig houthoudend, donker grijsbruin

Hiaat

Klei, zwak siltig, sterk humeus, zwak zandhoudend, zwak houtskoolhoudend, donker bruingrijs, bot, stukje leisteen, V12.1, zeven

Veen, zwak kleiïg, zwak houthoudend, donkerbruin, enkel grijs kleivlekje

Klei, matig siltig, zwak veenhoudend, bruingrijs, vlekkerig, wortel, geleidelijke overgang

Klei, matig siltig, zwak humeus, bruingrijs, geleidelijke overgang

Hiaat

Klei, zwak siltig, sterk humeus, grijsbruin, enigszins gelaagd, matig riethoudend

Veen, zwak kleiïg, matig houthoudend, grijsbruin

Hiaat

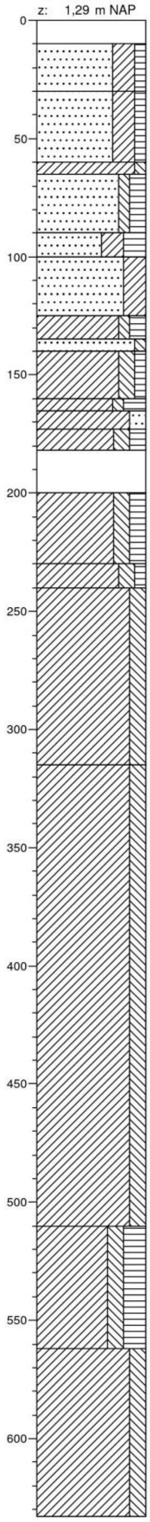
Klei, zwak siltig, sterk humeus, sporen planten, sporen hout, donkerbruin, enigszins vlekkerig

Klei, zwak siltig, sterk humeus, donker bruingrijs, gelaagde humusbanden

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 013 - 1

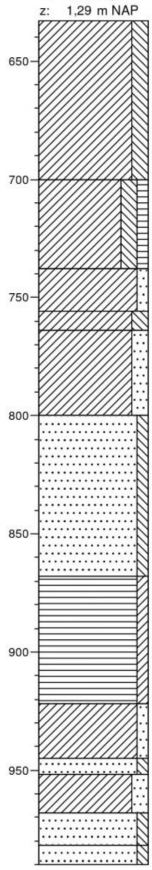
X: 108726,61
Y: 446963,94
z: 1,29 m NAP



- Paars, klinker
- Zand, uiterst fijn, kleiïg, zwak humeus, grijsbruin
- Zand, uiterst fijn, kleiïg, zwak humeus, matig puinhoudend, licht bruingrijs, 13.1 bot, roodbakkend aardewerk
- Klei, zwak siltig, grijs, 13.2 twee veldkeitjes/straatje?
- Zand, uiterst fijn, zwak siltig, matig humeus, matig puinhoudend, donkergrijs, mortel en rood/beige baksteenpuin
- Zand, uiterst fijn, kleiïg, sterk humeus, matig puinhoudend, donkergrijs, natte laag
- Zand, uiterst fijn, kleiïg, sterk puinhoudend, zwak grindhoudend, donkergrijs, roze en rood baksteenpuin
- Klei, zwak siltig, matig humeus, matig veenhoudend, donker bruinbruin, veenbrok?
- Zand, matig grof, zwak siltig, grijs, baksteenspikkels
- Klei, matig siltig, zwak humeus, grijs, donkergrijze vlekken
- Klei, zwak siltig, sterk humeus, zwak houthoudend, donker zwartgrijs, botspinters
- Klei, matig zandig, grijs, grote stukken bot
- Klei, matig siltig, matig humeus, donkergrijs, baksteenbrokje
- Hiaat
- Klei, matig siltig, matig humeus, grijsbruin, verbrand bot, slak? zeven
- Klei, matig siltig, zwak humeus, grijsbruin, sporen wortels, bodem, geleidelijk
- Klei, matig siltig, bruingrijs, egaal
- Klei, matig siltig, zwak houthoudend, grijs, donkergrijze vlekken, licht gelaagd
- Klei, matig siltig, sterk humeus, donker bruingrijs, donkere banden humus ca. 1-3 cm
- Klei, matig siltig, bruingrijs, iets lichtere humusbanden, lichtgrijs 2 mm

Boring: 013 - 2

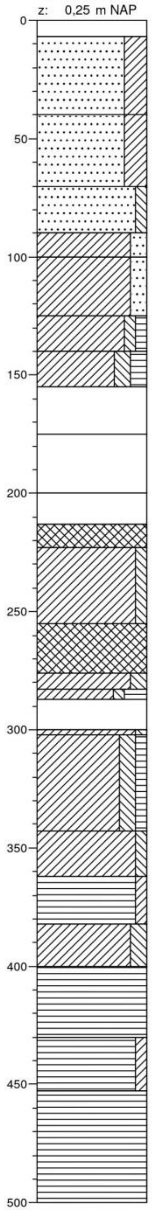
X: 108726,61
Y: 446963,94
z: 1,29 m NAP



- Klei, matig siltig, bruingrijs, iets lichtere humusbanden, lichtgrijs 2 mm
- Klei, matig siltig, zwak humeus, bruingrijs, vrij egaal
- Klei, zwak zandig, bruingrijs, fijnegelaagd
- Klei, matig siltig, grijs, fijngelaagd
- Klei, matig zandig, matig veenhoudend, donker grijsgrijs, fijngelaagde detritus
- Zand, uiterst fijn, zwak siltig, uiterst houthoudend, zwak schelphoudend, donkerbruin, vrijwel geheel grof detritu/ hout
- Veen, zwak kleiïg, bruin, dun zandlaagje op top, egaal, compact
- Klei, zwak zandig, zwak veenhoudend, bruingrijs, zand- en veenlaagjes
- Zand, matig grof, zwak siltig, grijs
- Klei, matig zandig, zwak veenhoudend, bruingrijs, gelaagd
- Zand, matig grof, zwak siltig, grijs
- Zand, uiterst fijn, zwak siltig, matig plantenhoudend, donker bruingrijs, gelaagd, detritus

Boring: 014

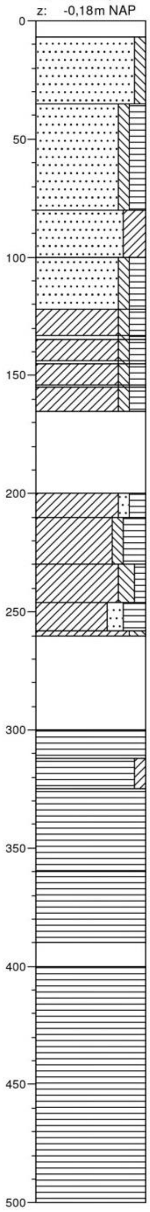
X: 108760,57
Y: 446972,87
z: 0,25 m NAP



- Paars, klinker
- Zand, uiterst fijn, kleiïg, bruingrijs
- Zand, uiterst fijn, kleiïg, matig puinhoudend, bruingrijs, rood en geel baksteenpuin
- Zand, uiterst fijn, zwak siltig, matig schelphoudend, sterk puinhoudend, bruingrijs, pijpenpot, cement, rode baksteen
- Klei, matig zandig, zwak houtskoolhoudend, bruingrijs, veenbrokjes
- Klei, matig zandig, zwak puinhoudend, donkergrijs, in liner, nat
- Klei, zwak siltig, zwak humeus, grijs, vlekkerig, randje fundering?
- Klei, matig siltig, matig humeus, donker grijsgrijs, 3 lagen rode baksteen+cement
- Geelrood, 3,5 laag baksteen+ cement
- Hiaat
- Bruin, hout, funderingsbalk
- Slib, bruin, opgebrachte veenlaag
- Klei, zwak siltig, grijsbruin, pakket veen- en kleibrokken
- Slib, bruin, opgebracht/los veenpakket
- Klei, matig siltig, lichtgrijs, kleibrok?
- Klei, zwak siltig, sterk humeus, zwak veenhoudend, donkergrijs, verkoolde? harde brokjes? aardewerk? bouwvoor
- Hiaat
- Klei, zwak siltig, donkergrijs, onderkant bouwvoor
- Klei, matig siltig, zwak humeus, bruingrijs, 1 tak op 315 cm, onderin iets bruiner
- Klei, zwak siltig, matig veenhoudend, matig houthoudend, bruingrijs, vrij scherpe top
- Veen, zwak kleiïg, matig houthoudend, donker bruinbruin
- Klei, matig siltig, zwak veenhoudend, zwak houthoudend, grijsbruin
- Veen, mineraalarm, matig houthoudend, bruin
- Veen, zwak kleiïg, donker bruinbruin
- Veen, mineraalarm, matig houthoudend, bruin

Boring: 015

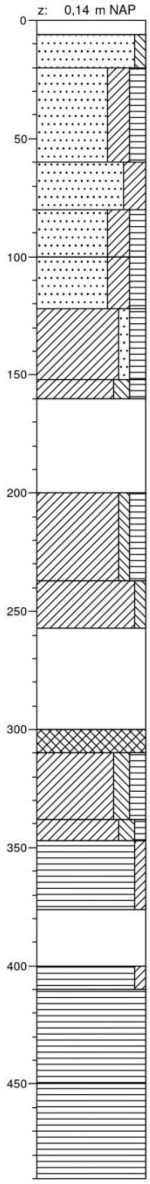
X: 108813,82
Y: 446977,07
z: -0,18m NAP



- Paars, klinker
- Zand, uiterst fijn, zwak siltig, zwak puinhoudend, lichtbruin, straatzand
- Zand, uiterst fijn, zwak siltig, matig humeus, matig puinhoudend, donkergrijs
- Zand, uiterst fijn, kleiïg, matig veenhoudend, zwak houthoudend, donker bruingrijs
- Zand, uiterst fijn, zwak siltig, matig humeus, sporen baksteen, grijs, kleine veenbrokjes
- Klei, zwak siltig, matig humeus, sterk veenhoudend, zwak schelphoudend, matig houthoudend, zwak houtskoolhoudend, donker grijsbruin
- Zand, uiterst fijn, zwak siltig, matig humeus, donkergrijs, straatniveautje?
- Klei, zwak siltig, matig humeus, sterk veenhoudend, matig houthoudend, sterk veenhoudend
- Zand, uiterst fijn, zwak siltig, matig humeus, donkergrijs, straatniveautje?
- Klei, zwak siltig, matig humeus, sterk veenhoudend, matig houthoudend, sterk veenhoudend, donker bruingrijs
- Zand, uiterst fijn, zwak siltig, matig humeus, donkergrijs, straatniveautje?
- Klei, zwak siltig, matig humeus, sterk veenhoudend, matig houthoudend, zwak veenhoudend, matig puinhoudend, donkergrijs, v15.1
- Hiaat
- Klei, zwak zandig, matig humeus, zwak houthoudend, zwak veenhoudend, donkergrijs
- Klei, zwak siltig, sterk humeus, sterk veenhoudend, matig houthoudend, zwak schelphoudend, donker zwartgrijs
- Klei, matig siltig, zwak humeus, zwak puinhoudend, zwak schelphoudend, zwak houthoudend, donker grijsgrijs, vlekkerig
- Klei, matig zandig, sterk humeus, sterk veenhoudend, matig puinhoudend, matig houthoudend, donker zwartbruin
- Klei, matig siltig, grijs
- Hiaat
- Veen, mineraalarm, zwak houthoudend, donkerbruin, donker veenbrok?
- Veen, zwak kleiïg, grijsbruin, zeer geleidelijke ondergrens
- Veen, mineraalarm, zwak houthoudend, bruin
- Veen, mineraalarm, matig houthoudend, bruin
- Hiaat
- Veen, mineraalarm, zwak houthoudend, bruin

Boring: 016

X: 108871,42
Y: 446997,99
z: 0,14 m NAP



Grijs, tegel

Zand, uiterst fijn, zwak siltig, geel

Zand, uiterst fijn, kleiïg, matig humeus, zwak puinhoudend, grijsbruin, pijpekopje, pijpenpot v16.1

Zand, uiterst fijn, kleiïg, zwak puinhoudend, bruingrijs

Zand, uiterst fijn, kleiïg, matig humeus, matig puinhoudend, bruingrijs, oranjerood baksteenpuin

Zand, uiterst fijn, kleiïg, matig humeus, zwak veenhoudend, matig puinhoudend, donkergrijs, v16.2 op 110 cm- mv veenbrokjes

Klei, zwak zandig, matig humeus, matig veenhoudend, grijsbruin, v16.3 bot, aardewerk

Klei, matig siltig, matig humeus, bruingrijs

Hiaat

Klei, zwak siltig, matig humeus, sporen baksteen, grijsbruin, donkere humusvlekjes, geheel vlekkerig

Klei, zwak siltig, sterk veenhoudend, donker grijsbruin

Hiaat

Slib, donkerbruin, venige ophoging

Klei, matig siltig, matig humeus, sterk veenhoudend, bruingrijs, klei/veenbrokken

Klei, matig siltig, zwak humeus, zwak veenhoudend, grijsbruin, kleine veenbrokjes komklei of ophoog?

Veen, zwak kleiïg, donker grijsbruin, bovenin kleivlekjes

Hiaat

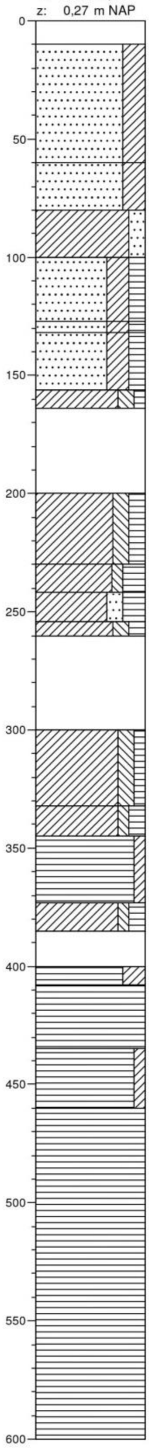
Veen, zwak kleiïg, donker bruinbruin

Veen, mineraalarm, zwak houthoudend, bruin

Veen, mineraalarm, matig houthoudend, roodbruin

Boring: 017

X: 108785,27
Y: 446884,95
z: 0,27 m NAP



Paars, klinker

Zand, uiterst fijn, kleiïg, zwak puinhoudend, lichtbruin

Zand, uiterst fijn, kleiïg, sterk puinhoudend, matig grindhoudend, grijs, geel en rood baksteenpuin

Klei, matig zandig, zwak puinhoudend, grijs

Zand, uiterst fijn, kleiïg, matig humeus, matig puinhoudend, grijs, vooral cementbrokjes, weinig rode baksteen

Zand, uiterst fijn, kleiïg, matig humeus, matig houtskoolhoudend, matig puinhoudend, grijsgrijs, houtskool, zeven?

Zand, uiterst fijn, kleiïg, matig humeus, matig puinhoudend, grijs, vooral cementbrokjes, weinig rode baksteen

Klei, matig siltig, zwak humeus, matig houthoudend, grijs, klei en zandbrokken

Hiaat

Klei, matig siltig, matig humeus, grijsbruin, brokken, kluiten

Klei, zwak siltig, sterk humeus, bruinzwart, mestige laag

Klei, matig zandig, sterk humeus, matig houtskoolhoudend, donker grijsgrijs, stevig, gelaagd, vloerniveautjes?

Klei, matig siltig, matig humeus, zwak baksteenhoudend, bruingrijs, vlekkerig

Hiaat

Klei, matig siltig, zwak humeus, zwak roesthoudend, bruingrijs, zweempje roest

Klei, zwak siltig, matig humeus, zwak veenhoudend, zwak houthoudend, grijsbruin, geleidelijke boven en ondergrens

Veen, zwak kleiïg, zwak houthoudend, grijsbruin, vrij scherpe ondergrens

Klei, zwak siltig, matig humeus, zwak houthoudend, grijsbruin, bovenin iets gelaagd

Hiaat

Veen, sterk kleiïg, zwak houthoudend, donker bruinbruin

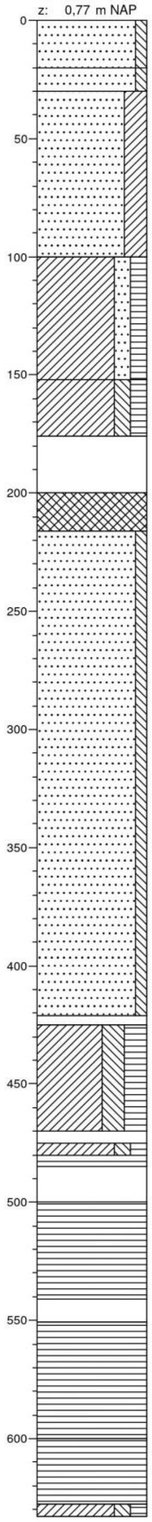
Veen, mineraalarm, matig houthoudend, bruin

Veen, zwak kleiïg, grijsbruin, licht riethoudend

Veen, mineraalarm, zwak houthoudend, bruin, licht riethoudend

Boring: 018 - 1

X: 108825,35
Y: 446791,94
z: 0,77 m NAP



Zand, uiterst fijn, zwak siltig, sterk teelaardehoudend, donkerbruin

Zand, uiterst fijn, zwak siltig, zwak teelaardehoudend, matig puinhoudend, lichtbruin

Zand, uiterst fijn, kleiïg, zwak grindhoudend, zwak puinhoudend, donker grijsbruin, sintels, 1 plateelscherf

Klei, matig zandig, matig humeus, zwak roesthoudend, zwak grindhoudend, sporen baksteen, donker roodgrijs

Klei, matig siltig, matig humeus, sporen baksteen, donkergrijs

Hiaat

Slib, sporen puin, donker zwartbruin, venig pakket

Zand, uiterst fijn, zwak siltig, volledig puin, rood, brokken baksteen en cement

Donker grijsbruin, hout, plank? v18.1, en lagen leisteen

Klei, sterk siltig, sterk humeus, donker zwartgrijs, bovenin losse leisteen

Rode baksteen

Klei, matig siltig, matig humeus, donkergrijs

Veen, mineraalarm, donkerbruin, in corecatcher

Hiaat

Veen, mineraalarm, zwak houthoudend, bruin, licht riethoudend

Hout, boomstammetje

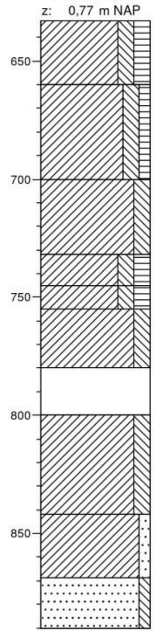
Veen, mineraalarm, zwak houthoudend, bruin, licht riethoudend

Veen, mineraalarm, matig houthoudend, bruin

Klei, matig siltig, matig humeus, zwak veenhoudend, zwak houthoudend, grijsbruin, vlekkerig

Boring: 018 - 2

X: 108825,35
Y: 446791,94
z: 0,77 m NAP



Klei, matig siltig, matig humeus, zwak veenhoudend, zwak houthoudend, grijsbruin, vlekkerig

Klei, matig siltig, zwak humeus, bruingrijs, humeuze vlekjes

Klei, matig siltig, bruingrijs, licht kalkhoudend, iets vlekkerig

Klei, matig siltig, matig humeus, zwak veenhoudend, zwak houthoudend, bruingrijs, laklaag, scherpe top, diffuus onder

Klei, matig siltig, matig humeus, matig veenhoudend, matig houthoudend, bruingrijs, bodempje, scherpe top, diffuus onder

Klei, matig siltig, grijs, kleine humeuze vlekjes

Hiaat

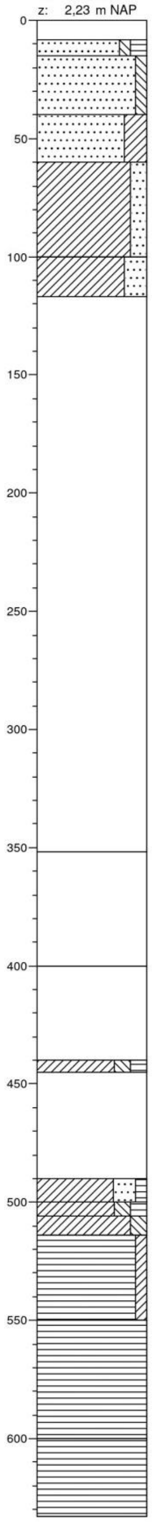
Klei, matig siltig, grijs, kleine humusvlekjes

Klei, zwak zandig, grijs, kleine humusvlekjes

Zand, zeer grof, zwak siltig, grijs, bovenin kleibrokje/laagje 2 cm dik

Boring: 019 - 1

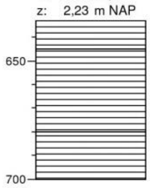
X: 108794,76
Y: 446766,82
z: 2,23 m NAP



- Paars, klinker
- Zand, uiterst fijn, zwak siltig, matig humeus, zwak puinhoudend, grijsbruin
- Zand, uiterst fijn, zwak siltig, bruingeel, schoon
- Zand, uiterst fijn, kleïig, matig puinhoudend, bruingrijs, rood en geel baksteenpuin en mortel
- Klei, matig zandig, matig puinhoudend, grijsbruin, rood baksteenpuin en mortel
- Klei, sterk zandig, sterk puinhoudend, grijsbruin, vooral cement
- Rood en geel baksteenpuin en cement
- Hiaat
- Grof puin, geelrood /roze baksteen onderste daktegel
- Klei, matig siltig, matig humeus, bruingrijs, slap, nat
- Hiaat
- Klei, sterk zandig, zwak humeus, sporen puin, bruingrijs, leisteen, v19.1 klein bot zeven?
- Klei, matig siltig, matig humeus, leisteen baksteen
- Klei, matig siltig, zwak roesthoudend, bruingrijs
- Veen, zwak kleïig, zwak houthoudend, grijsbruin, bovenin schuin hout paaltje/ tak v19.2
- Veen, mineraalarm, zwak houthoudend, bruin, nog heel licht kleiig?
- Veen, mineraalarm, matig houthoudend, bruin, licht riethoudend

Boring: 019 - 2

X: 108794,76
Y: 446766,82
z: 2,23 m NAP

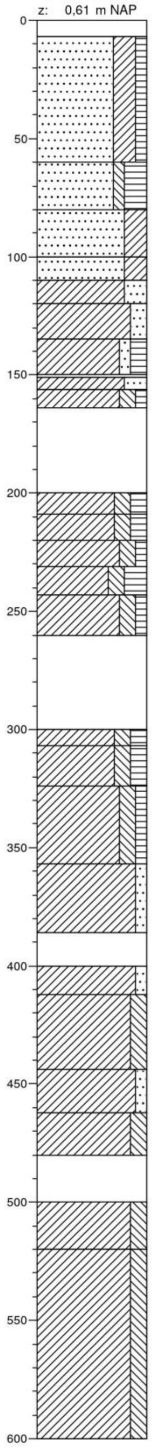


- Veen, mineraalarm, matig houthoudend, bruin, licht riethoudend
- Veen, mineraalarm, bruin, matig riethoudend
- Veen, mineraalarm, matig houthoudend, bruin, licht riethoudend

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 020

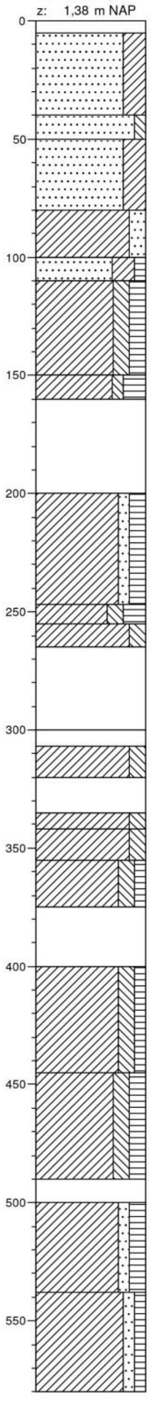
X: 108696,69
Y: 447126,04
z: 0,61 m NAP



- Geel, klinker
- Zand, uiterst fijn, kleiïg, zwak humeus, geelbruin
- Zand, uiterst fijn, zwak siltig, sterk humeus, donkergrijs, pijpesteel, veel bot, monster
- ▲ Zand, uiterst fijn, kleiïg, zwak roesthoudend, donkergrijs, leisteen, bot, baksteen, monster?
- ▲ Zand, uiterst fijn, kleiïg, sporen puin, grijsbruin
- ▲ Klei, sterk zandig, sporen puin, grijsbruin
- ▲ Klei, matig zandig, sporen puin, grijsbruin, lichtgrijze vlekjes, v20.1 roodbakkend aardewerk, lei
- ▲ Klei, zwak zandig, matig humeus, donker bruingrijs, v20.2 bot
- Bruin, v20.3 liggend hout, kist
- Klei, sterk zandig, matig puinhoudend, zwak roesthoudend, bruinrood
- Klei, matig siltig, zwak humeus, bruingrijs
- Hiaat
- ▲ Klei, matig siltig, matig humeus, grijsbruin, iets vlekkerig
- ▲ Klei, matig siltig, matig humeus, matig houtskoolhoudend, donker bruingrijs, v20.4 grijsbakkend aardewerk
- Klei, matig siltig, zwak humeus, grijsbruin, kalkloos, enkele humusvlekjes
- Klei, matig siltig, sterk humeus, zwak houtskoolhoudend, donker bruingrijs, laklaag, kalkloos, zeven?
- Klei, matig siltig, zwak humeus, bruingrijs, kalkrijk, licht vlekkerig
- Hiaat
- Klei, matig siltig, matig humeus, grijsbruin, alle klei hieronder kalkrijk
- ▲ Klei, matig siltig, matig humeus, zwak houthoudend, bruingrijs, enkele gelige vlekken
- Klei, matig siltig, zwak humeus, donker grijsgrijs, fijngelaagd
- ▲ Klei, zwak zandig, zwak veenhoudend, matig houthoudend, donker grijsgrijs, iets gelaagd, vlekkerig
- Hiaat
- ▲ Klei, zwak zandig, zwak veenhoudend, matig houthoudend, donker grijsgrijs, iets gelaagd, vlekkerig, v20.5
- ▲ Klei, matig siltig, zwak schelphoudend, bruingrijs
- ▲ Klei, zwak zandig, zwak veenhoudend, matig houthoudend, donker grijsgrijs
- Klei, matig siltig, grijsbruin, enkele lichtgrijze vlek 3 cm
- Hiaat
- ▲ Klei, matig siltig, matig houthoudend, bruingrijs
- Klei, matig siltig, donker bruingrijs, enkele lichtgrijze vlekken 4-5 cm

Boring: 021

X: 108674,88
Y: 447101,94
z: 1,38 m NAP

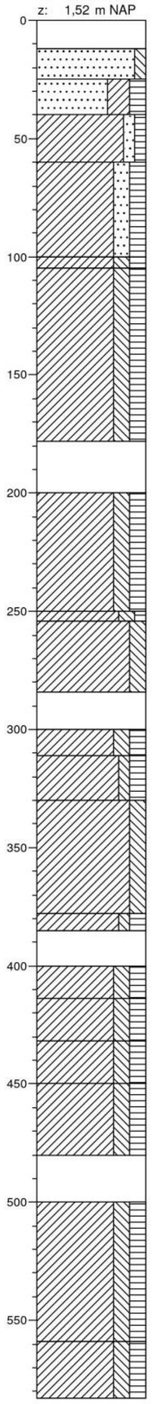


- Geel, platte klinker
- ▲ Zand, uiterst fijn, kleiïg, zwak puinhoudend, bruingrijs
- ▲ Zand, uiterst fijn, zwak siltig, zwak puinhoudend, bruingeel
- ▲ Zand, uiterst fijn, kleiïg, matig puinhoudend, grijs, roodbakkend aardewerk v21.1
- ▲ Klei, matig zandig, matig puinhoudend, grijs, rood baksteenpuin, monster
- ▲ Zand, uiterst fijn, kleiïg, zwak humeus, sterk baksteenhoudend, grijsbruin, groot brok baksteen
- ▲ Klei, matig siltig, matig humeus, zwak puinhoudend, grijs, donkere humusvlekken
- ▲ Klei, zwak siltig, sterk humeus, sterk puinhoudend, donker zwartgrijs, puin/brandlaag? v21.2
- Hiaat
- ▲ Klei, zwak zandig, matig humeus, matig puinhoudend, grijs, vlekkerig, nat, rood baksteenpuin en mortel
- ▲ Klei, matig siltig, sterk humeus, matig puinhoudend, grijsbruin, cultuurlaagje v21.3 aardewerk, bot
- ▲ Klei, matig siltig, sporen puin, grijs, mortelspikkels
- Hiaat
- Donkerbruin, hout
- Klei, matig siltig, beigegrijs, kalkrijke klei, zweempje roest?
- Hout, staand
- Klei, matig siltig, beigegrijs
- ▲ Klei, matig siltig, zwak plantenhoudend, bruingrijs, deel van rechtopstaand hout
- Klei, matig siltig, zwak humeus, bruingrijs, zeer fijne plantenresten, iets gelaagd?
- Hiaat
- Klei, matig siltig, zwak humeus, bruingrijs, zeer fijne plantenresten, iets gelaagd?
- Klei, matig siltig, matig humeus, bruingrijs, humeuze banden ca. 1-2 cm dik
- Hiaat
- Klei, zwak zandig, matig humeus, grijsbruin, enkele kleine lichte vlekjes
- Klei, zwak zandig, zwak humeus, bruingrijs, enkele donkere laagjes fijne plantenrest

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 022

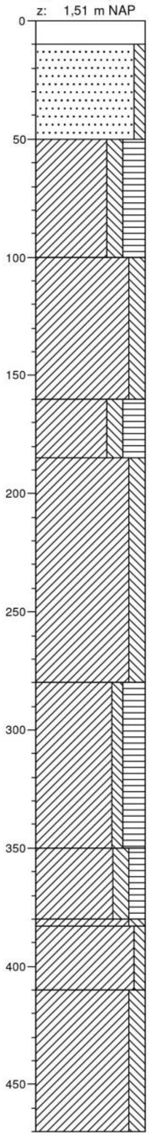
X: 108663,54
Y: 447092,44
z: 1,52 m NAP



- Kinderkopje
- Zand, uiterst fijn, zwak siltig, bruingeel
- Zand, uiterst fijn, kleiïg, matig humeus, zwak puinhoudend, grijs
- Klei, zwak zandig, zwak humeus, sporen puin, grijs, veenbrokjes, monster
- Klei, matig zandig, matig humeus, grijsbruin
- Klei, matig siltig, matig humeus, zwak baksteenhoudend, zwak grindhoudend, grijsbruin, ijsselsteen
- Klei, matig siltig, matig humeus, zwak veenhoudend, bruingrijs
- Hiaat
- Klei, matig siltig, matig humeus, zwak veenhoudend, bruingrijs
- Klei, matig siltig, zwak humeus, zwak houtskoolhoudend, donker grijsgrijs, kleine vlekjes, loopvlakje?
- Klei, matig siltig, zwak roesthoudend, beigegrijs, kalk/roestbrokjes
- Hiaat
- Klei, matig siltig, matig humeus, zwak roesthoudend, bruingrijs, vllekkerig,
- Klei, zwak siltig, matig humeus, sporen veen, sporen hout, zwak houtskoolhoudend, bruingrijs, vivianiet, houtskool? zeven
- Klei, matig siltig, grijsbruin, enkel klein veenbrokje/houtje
- Klei, zwak siltig, matig humeus, zwak houthoudend, matig veenhoudend, bruingrijs
- Hiaat
- Klei, matig siltig, matig humeus, matig houthoudend, zwak veenhoudend, grijsbruin
- Klei, matig siltig, matig humeus, grijsbruin, kleine humusvlekjes
- Klei, matig siltig, matig humeus, zwak houthoudend, grijsbruin
- Klei, matig siltig, matig humeus, bruingrijs, gelaagd, bandjes 1-5 mm
- Hiaat
- Klei, matig siltig, matig humeus, matig plantenhoudend, zwak houthoudend, grijsbruin, zeer fijn gelaagd
- Klei, matig siltig, matig humeus, grijsbruin, gelaagd, dikkere bandjes 1-10 mm grijs

Boring: 023

X: 108651,6
Y: 447080,23
z: 1,51 m NAP

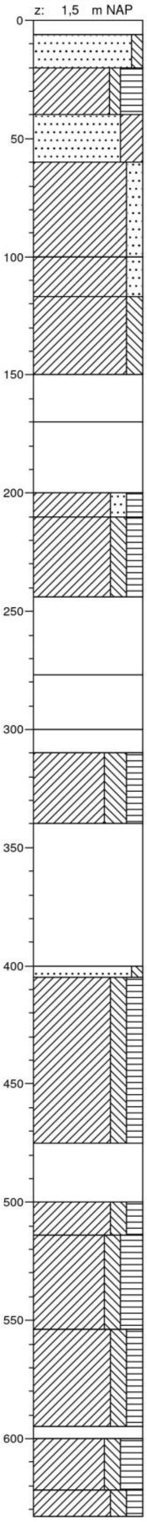


- Geel, klinker
- Zand, uiterst fijn, zwak siltig, zwak puinhoudend, geelbruin
- Klei, matig siltig, sterk humeus, matig puinhoudend, donkergrijs, zwarte vlekken, ijsselsteen en rode baksteen
- Klei, matig siltig, zwak roesthoudend, licht beigegrijs
- Klei, matig siltig, sterk humeus, donkergrijs, monster 1
- Klei, matig siltig, grijsgrijs, vlekkerig, brokken
- Klei, zwak siltig, sterk humeus, matig veenhoudend, donker grijsbruin, vivianiet, plaggen?
- Klei, matig siltig, matig humeus, bruingrijs, aardewerk v 23.1 monster 2
- Klei, matig siltig, lichtgrijs
- Klei, zwak siltig, sterk veenhoudend, zwak houthoudend, bruin, monster 3
- Klei, matig siltig, zwak veenhoudend, zwak plantenhoudend, bruingrijs, fijngelaagd, riethoudend

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 024 - 1

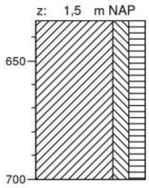
X: 108621,29
Y: 447060,6
z: 1,5 m NAP



- Grijs, tegel
- Zand, uiterst fijn, zwak siltig, bruingeel
- ▲ Klei, zwak siltig, sterk humeus, matig teelaardehoudend, zwak houthoudend, zwak puinhoudend, donker zwartbruin, tuingrond
- ▲ Zand, uiterst fijn, kleiïg, zwak puinhoudend, licht bruingrijs, cement, rood baksteenpuin
- ▲ Klei, matig zandig, matig puinhoudend, licht bruinbruin, rozerood baksteenpuin, wit cement
- ▲ Klei, matig zandig, matig puinhoudend, grijsbruin, 6 laagjes mortel/puin/ humeuze klei
- ▲ Klei, matig siltig, matig roesthoudend, sporen puin, grijsbeige, onderin zwarte veenbrokjes
- Muurwerk, 3 lagen baksteen, 3 cement
- Hiaat
- ▲ Klei, matig zandig, matig humeus, zwak puinhoudend, grijs
- ▲ Klei, matig siltig, matig humeus, matig houthoudend, zwak veenhoudend, zwak puinhoudend, donker grijsgrijs, staand houtje?
- Muurwerk, 4 lagen rood(bruine) baksteen, 4 lagen cement
- Hiaat
- Muurwerk, baksteen met cement
- ▲ Klei, sterk siltig, matig humeus, zwak puinhoudend, uiterst houthoudend, grijsbruin, schuin hout, v24.1 brokje zandsteen
- Hiaat
- Zand, uiterst fijn, zwak siltig, lichtgrijs, baksteenbrok
- ▲ Klei, matig siltig, matig humeus, matig houthoudend, zwak veenhoudend, grijsbruin, vlekkerig , natuurlijk
- Hiaat
- Klei, matig siltig, matig humeus, bruingrijs, egaal
- Klei, matig siltig, sterk humeus, donker bruingrijs, licht vlekkerig
- Klei, matig siltig, matig humeus, donker grijsgrijs, humeuze banden ca 1-2 cm
- Hiaat
- Klei, matig siltig, sterk humeus, donkergrijs
- Klei, matig siltig, matig humeus, donker grijsgrijs, enkele lichtgrijze vlekken/ bandjes

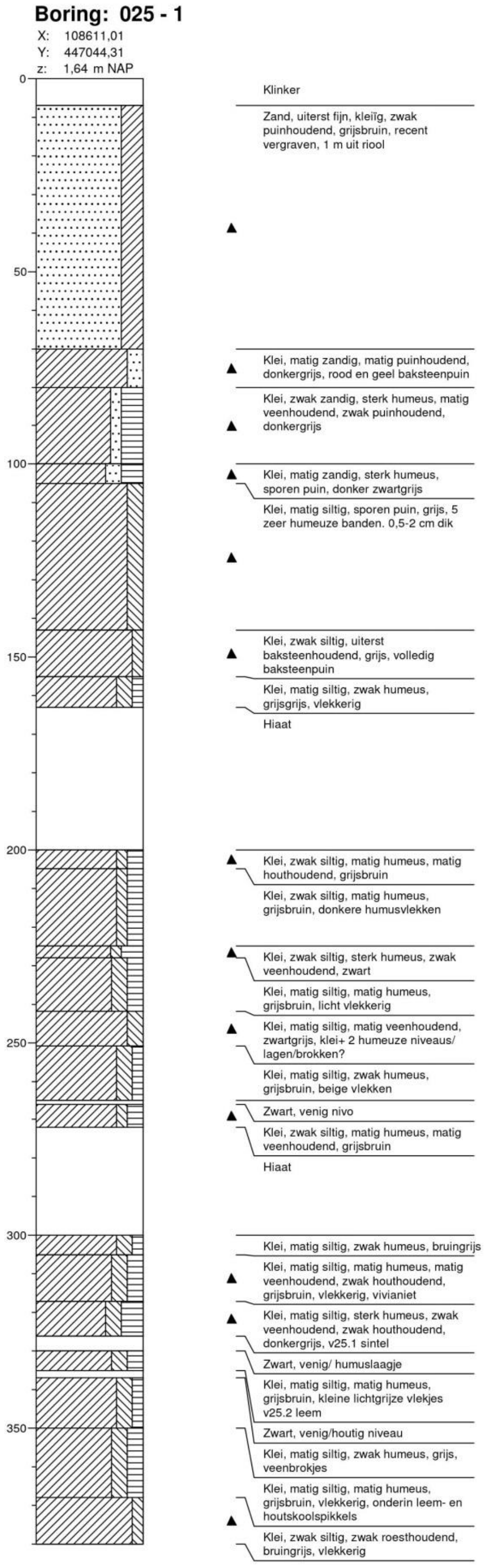
Boring: 024 - 2

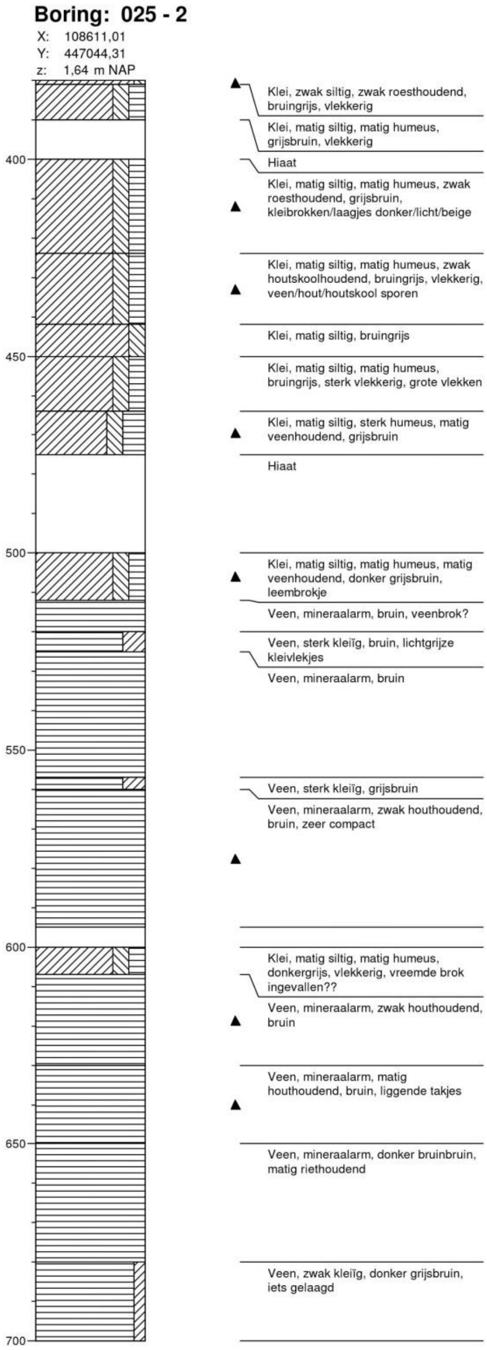
X: 108621,29
Y: 447060,6
z: 1,5 m NAP



- Klei, matig siltig, matig humeus, donker grijsgrijs, enkele lichtgrijze vlekken/ bandjes

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

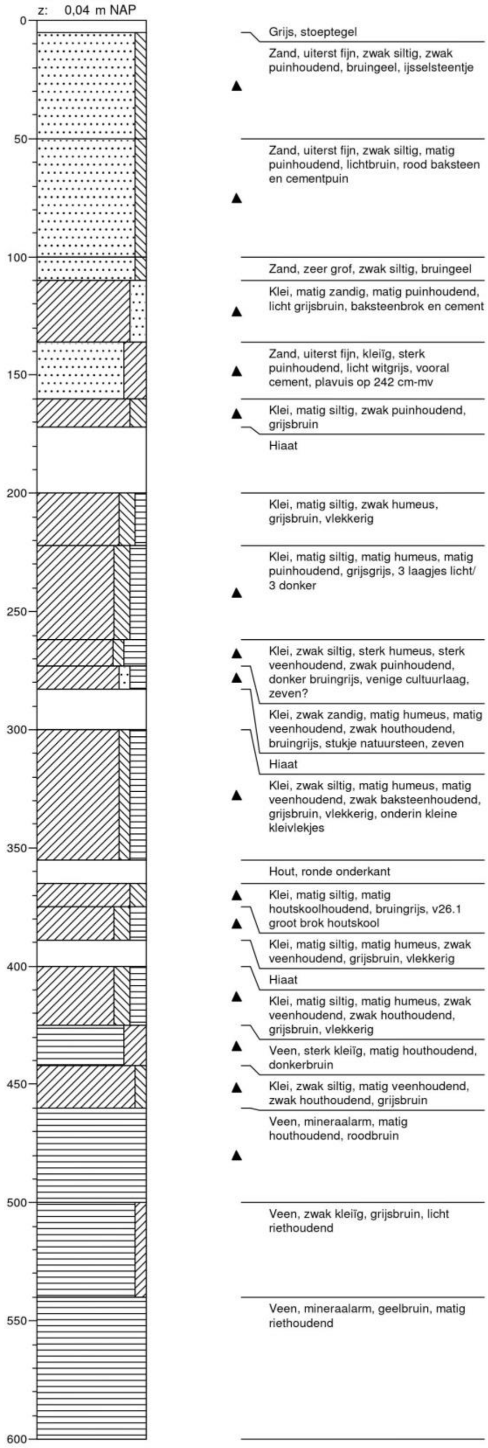




Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 026

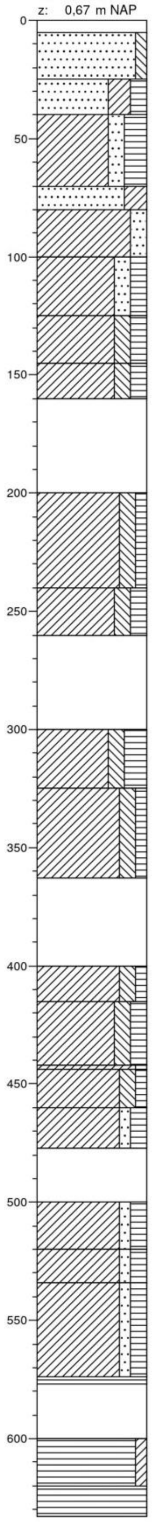
X: 108778,36
Y: 447154,24
z: 0,04 m NAP



Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 027 - 1

X: 108739,31
Y: 447147,97
z: 0,67 m NAP



Grijs, tegel

Zand, uiterst fijn, zwak siltig, bruingeel

Zand, uiterst fijn, kleiïg, matig humeus, zwak puinhoudend, grijsbruin, rozerood baksteenpuin

Klei, matig zandig, sterk humeus, matig puinhoudend, zwak schelphoudend, zwak houtskoolhoudend, donkergrijs, stug, rood en geel baksteenpuin, v27.1,

Zand, uiterst fijn, kleiïg, matig puinhoudend, grijs, leisteen

Klei, matig zandig, sterk puinhoudend, grijs, geelroze baksteenpuin

Klei, matig zandig, matig humeus, sterk puinhoudend, grijs, rozegeel baksteenpuin

Klei, matig siltig, matig humeus, matig puinhoudend, grijs, metaalslak, zeven? v27.2

Klei, matig siltig, matig humeus, zwak veenhoudend, grijsbruin

Hiaat

Klei, matig siltig, zwak humeus, zwak roesthoudend, bruingrijs, kleine humusvlekjes

Klei, matig siltig, matig humeus, zwak veenhoudend, grijsbruin, enkele grijze kleivlek

Hiaat

Klei, matig siltig, sterk humeus, zwak schelphoudend, zwak houthoudend, donker zwartgrijs, grote slak/schelp geultje?

Klei, matig siltig, zwak humeus, bruingrijs, vlekkerig

Hiaat

Klei, matig siltig, zwak humeus, beigegrijs, 2 lichte laagjes

Klei, matig siltig, matig humeus, zwak plantenhoudend, grijsbruin, licht gelaagd

Klei, zwak zandig, sterk plantenhoudend, zwak veenhoudend, donker zwartbruin, gelaagd, fijne plantenresten

Klei, matig siltig, zwak humeus, donker grijsgrijs, vlekkerig

Klei, zwak zandig, matig humeus, grijsbruin, kleine humusvlekjes

Hiaat

Klei, zwak zandig, matig humeus, grijsbruin, kleine humusvlekjes

Klei, zwak zandig, matig humeus, matig veenhoudend, zwak houthoudend, matig schelphoudend, grijs

Klei, zwak zandig, matig humeus, matig veenhoudend, matig houthoudend, donker grijsgrijs, verspoeld? veen/hout bodem geul

Veen, mineraalarm, bruin, matig riethoudend

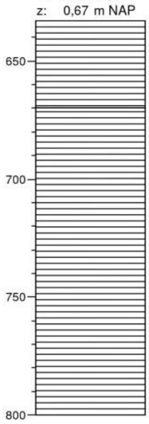
Hiaat

Veen, zwak kleiïg, grijsbruin, matig riethoudend

Veen, mineraalarm, bruin, matig riethoudend

Boring: 027 - 2

X: 108739,31
Y: 447147,97
z: 0,67 m NAP



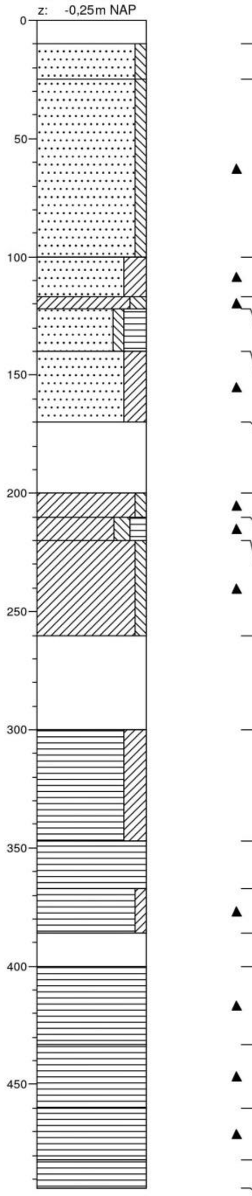
Veen, mineraalarm, bruin, matig riethoudend

Veen, mineraalarm, zwak houthoudend, bruin, matig riethoudend

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 028

X: 108695,43
Y: 447236,54
z: -0,25m NAP



Rood, klinker

Zand, uiterst fijn, zwak siltig, grijsbruin

Zand, uiterst fijn, zwak siltig, zwak puinhoudend, donkergrijs, nat, recent, reductie

Zand, uiterst fijn, kleiïg, zwak puinhoudend, zwak grindhoudend, grijs

Klei, matig siltig, zwak puinhoudend, licht grijsgrijs, mortelspikkels

Zand, uiterst fijn, zwak siltig, sterk humeus, donker zwartgrijs, metaalslak/ sintels

Zand, uiterst fijn, kleiïg, sterk puinhoudend, grijsbruin, v28.1 aardewerk

Hiaat

Klei, zwak siltig, uiterst houthoudend, donkerbruin, paal?

Klei, matig siltig, matig humeus, zwak houthoudend, donker grijsgrijs, metaalslakjes, zeven,?

Klei, zwak siltig, matig houthoudend, matig veenhoudend, grijsbruin, lichtgrijs kleivlekje v28.2 bot 247 cm-mv

Hiaat

Veen, sterk kleiïg, bruingrijs, veen/turfbrok op 314 cm, vivianietspikkels

Veen, mineraalarm, bruingroen, sterk gelaagd riet/ mest onderzoeken botanie?

Veen, zwak kleiïg, zwak houthoudend, grijsbruin

Hiaat

Veen, mineraalarm, zwak houthoudend, bruin

Veen, mineraalarm, sterk houthoudend, bruin

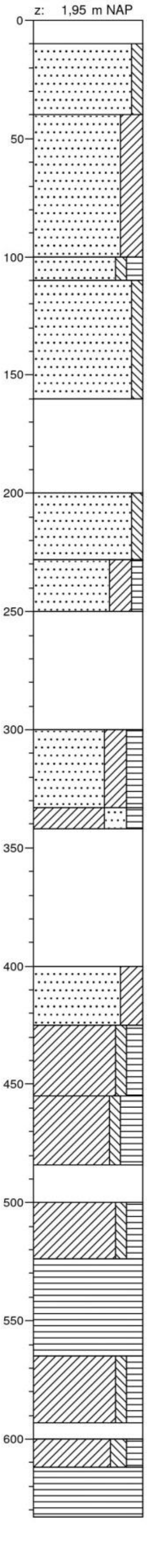
Veen, mineraalarm, zwak houthoudend, bruin

Veen, mineraalarm, groenbruin, matig riethoudend

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 029 - 1

X: 108581,73
Y: 447030,95
z: 1,95 m NAP



Kinderkopje

Zand, uiterst fijn, zwak siltig, geelbruin

Zand, uiterst fijn, kleiïg, zwak puinhoudend, geelbruin, recent

Zand, uiterst fijn, zwak siltig, matig humeus, zwak wortelhoudend, grijsbruin

Zand, uiterst fijn, zwak siltig, zwak roesthoudend, matig baksteenhoudend, licht geelbruin, baksteen/plavuisbrokken

Hiaat

Zand, uiterst fijn, zwak siltig, zwak puinhoudend, zwak schelphoudend, licht geelbruin

Zand, uiterst fijn, kleiïg, zwak humeus, matig puinhoudend, grijsbruin, dakpan, gele baksteenbrok

Hiaat

Zand, uiterst fijn, kleiïg, matig humeus, matig baksteenhoudend, donker grijsgrijs, oranje/gele baksteenbrokken

Klei, sterk zandig, matig humeus, sporen puin, donker grijsgrijs

Hiaat

Zand, uiterst fijn, kleiïg, matig veenhoudend, sporen baksteen, donkergrijs, rommelig, veen en kleibrokken

Klei, zwak siltig, matig humeus, zwak veenhoudend, donker grijsgrijs, kleibrokken+ 1venig brokje

Klei, zwak siltig, sterk humeus, zwak plantenhoudend, donker grijsbruin, gelige vlekjes + 1geelbruin zandig laagje

Hiaat

Klei, zwak siltig, matig humeus, matig veenhoudend, zwak houtskoolhoudend, zwak houthoudend, donker bruingrijs, zeven, houtskool?

Veen, mineraalarm, matig houthoudend, bruin, opgebracht?

Klei, zwak siltig, matig humeus, zwak veenhoudend, donker grijsgrijs, kleibrokken, bovenin veenbrok

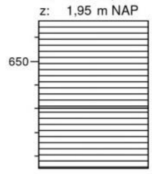
Hiaat

Klei, matig siltig, matig humeus, zwak veenhoudend, grijsbruin, vrij scherpe overgang

Veen, mineraalarm, zwak houthoudend, bruin

Boring: 029 - 2

X: 108581,73
Y: 447030,95
z: 1,95 m NAP



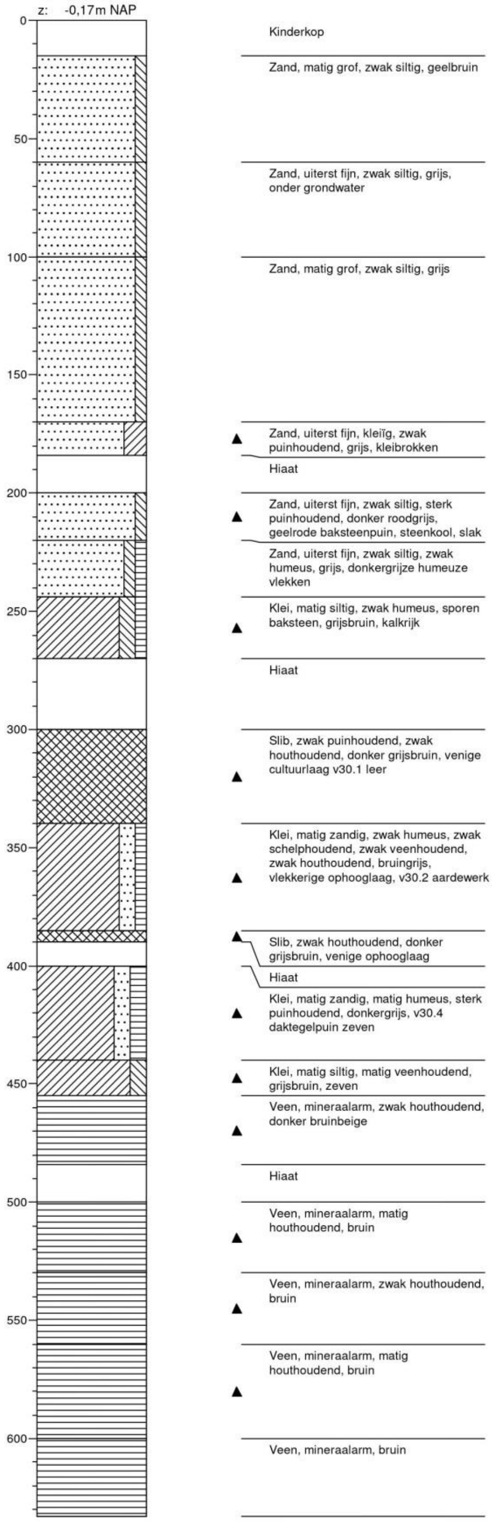
Veen, mineraalarm, zwak houthoudend, bruin

Veen, mineraalarm, geelbruin, licht riethoudend, licht gelaagd

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

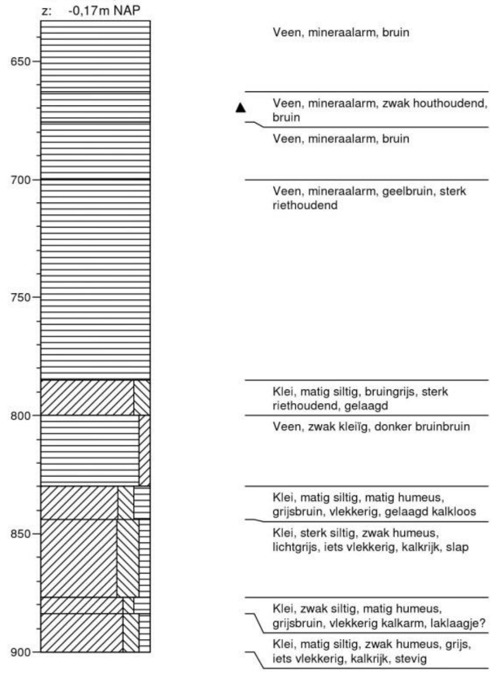
Boring: 030 - 1

X: 108585,68
Y: 447252,33
z: -0,17m NAP

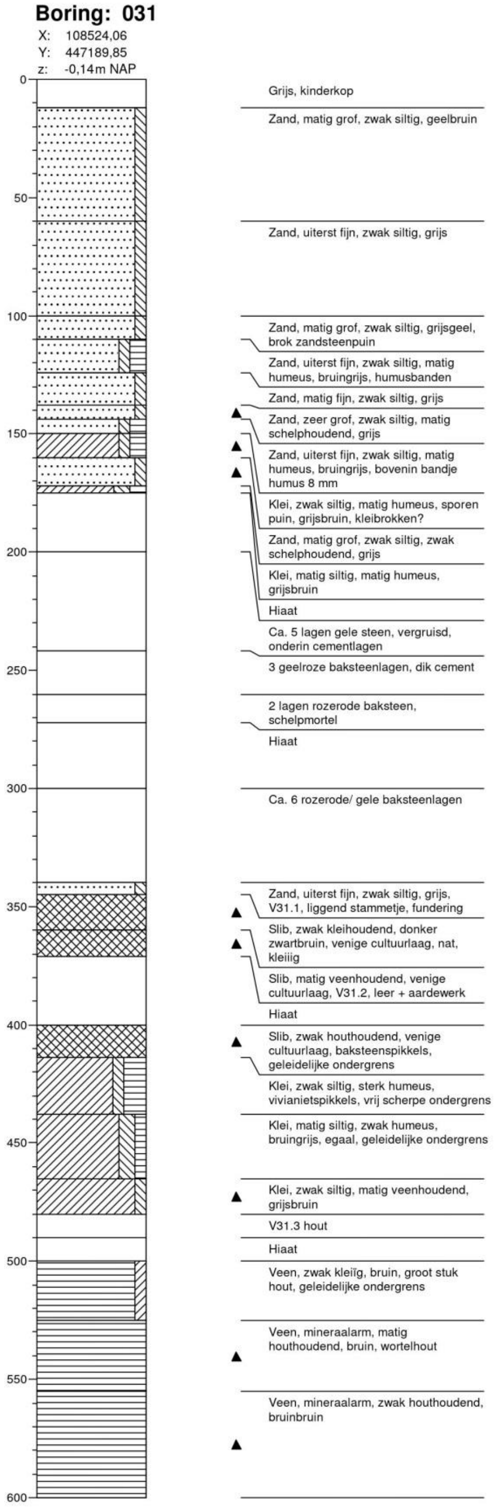


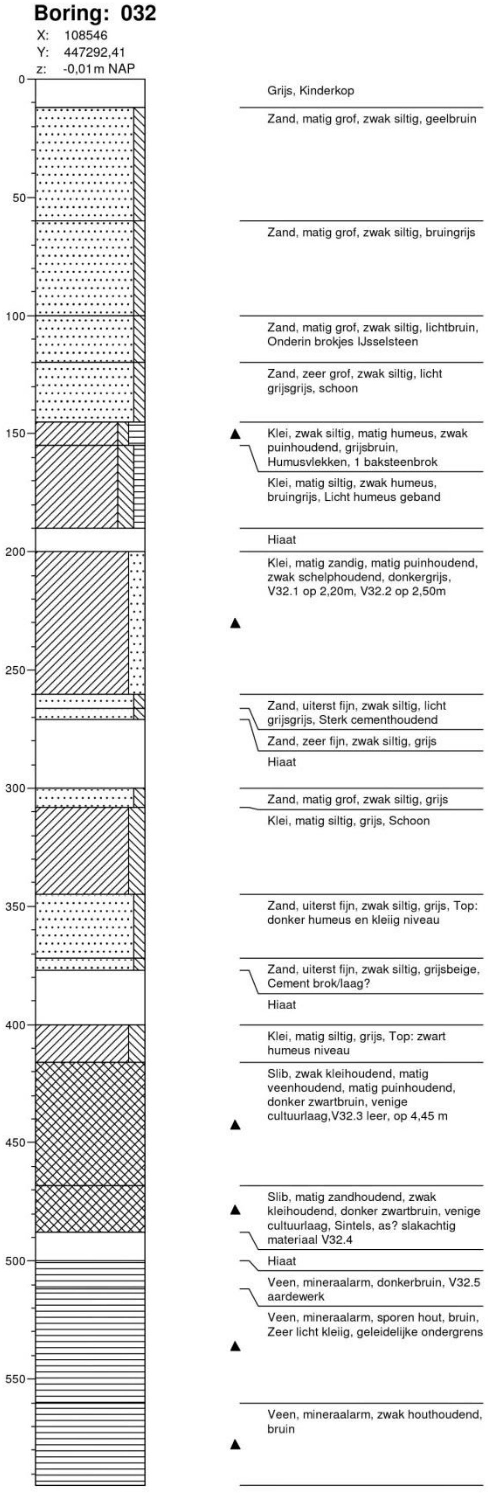
Boring: 030 - 2

X: 108585,68
Y: 447252,33
z: -0,17m NAP



Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

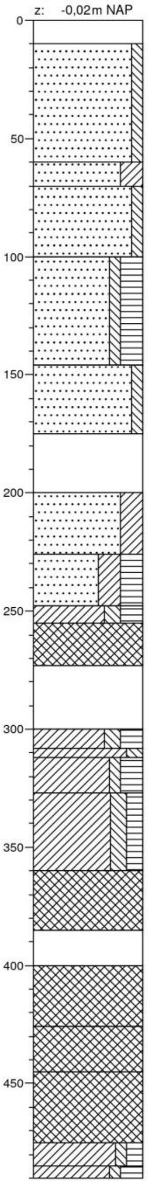




Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 033

X: 108585,97
Y: 447355,68
z: -0,02m NAP



Paars, klinker

Zand, matig grof, zwak siltig, geelbruin

▲ Zand, uiterst fijn, kleiïg, sterk puinhoudend, zwartgrijs, Sintels, ovenslak etc.

▲ Zand, uiterst fijn, zwak siltig, sterk puinhoudend, grijs

Zand, uiterst fijn, zwak siltig, sterk humeus, bruingrijs, IJsselsteen op 120-125 cm

▲ Zand, uiterst fijn, zwak siltig, sterk puinhoudend, donker grijsgrijs, Cement, roze baksteen, onderin daktegel

Hiaat

▲ Zand, uiterst fijn, kleiïg, sterk veenhoudend, matig puinhoudend, grijsbruin, Grote cementbrok, rood baksteenpuin

Zand, uiterst fijn, kleiïg, sterk humeus, donker zwartgrijs, Cultuurlaag, veel bot, schelp V33.1

Klei, matig siltig, sterk humeus, donkergrijs

▲ Slib, sterk veenhoudend, matig puinhoudend, donker zwartbruin, venige cultuurlaag, V33.2 leer, visbot, hazelnoot, rood baksteenpuin

Hiaat

▲ Klei, matig siltig, sterk humeus, zwak puinhoudend, zwart, slibachtig

▲ Klei, matig siltig, grijs, kleibrokje

Klei, zwak siltig, sterk humeus, matig veenhoudend, sporen puin, donker bruingrijs

▲ Klei, matig siltig, matig humeus, zwak puinhoudend, grijsbruin, enkel baksteenpuintje, geleidelijke ondergrens

▲ Slib, matig veenhoudend, donker bruingrijs, venige cultuurlaag

Hiaat

▲ Slib, sterk veenhoudend, zwak kleihoudend, sporen puin, zwak houthoudend, donker grijsbruin, venige cultuurlaag

▲ Slib, matig veenhoudend, matig kleihoudend, donker bruingrijs, venige cultuurlaag

▲ Slib, sterk veenhoudend, matig houthoudend, zwak kleihoudend, donker zwartbruin, venige cultuurlaag

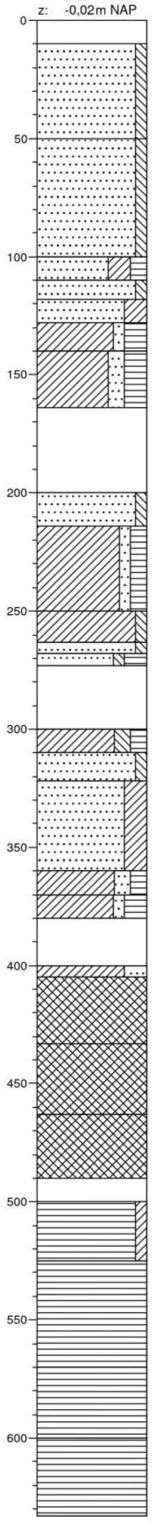
▲ Klei, zwak siltig, matig humeus, zwak veenhoudend, matig houtskoolhoudend, bruingrijs, scherpe ondergrens

▲ Klei, zwak siltig, sterk humeus, zwak houthoudend, zwart

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 034 - 1

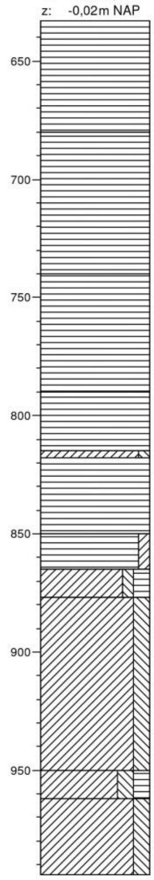
X: 108572,76
Y: 447447,3
z: -0,02m NAP



- Paars, Klinker
- Zand, uiterst fijn, zwak siltig, grijsbruin
- Zand, uiterst fijn, zwak siltig, matig puinhoudend, grijs, Recent vensterglas, betonpuin
- Zand, uiterst fijn, kleïïg, matig humeus, sterk puinhoudend, donkergrijs
- Zand, uiterst fijn, zwak siltig, sporen puin, bruingeel, Oxidatie
- Zand, uiterst fijn, kleïïg, matig puinhoudend, grijs, Reductie
- Klei, zwak zandig, sterk humeus, sporen puin, donkergrijs
- Klei, matig zandig, sterk humeus, matig puinhoudend, donker zwartgrijs
- Hiaat
- Zand, uiterst fijn, zwak siltig, uiterst puinhoudend, rood, 34.1 aardewerk, metselpleister
- Klei, zwak zandig, matig humeus, donker bruingrijs, 5 dunne ophooglaagjes, aslaag?
- Klei, zwak siltig, bruingrijs
- Zand, uiterst fijn, zwak siltig, grijs
- Zand, uiterst fijn, zwak siltig, sterk humeus, zwart, Brandlaag? Sintels?
- Hiaat
- Klei, matig siltig, matig humeus, sporen puin, grijs, donkergrijze vlekjes
- Zand, uiterst fijn, zwak siltig, sterk veenhoudend, zwak kleihoudend, donker zwartgrijs
- Zand, uiterst fijn, kleïïg, sterk puinhoudend, roodgrijs, Rood en geel baksteenpuin
- Klei, matig zandig, matig humeus, sporen puin, grijs
- Klei, zwak zandig, sterk humeus, matig veenhoudend, donkergrijs, Mosselschelp
- Hiaat
- Klei, sterk zandig, zwak puinhoudend, grijs, Cement
- Slib, sterk veenhoudend, zwak puinhoudend, donkerbruin, venige cultuurlaag, rozerood baksteenbrok
- Slib, sterk veenhoudend, zwak kleihoudend, donker grijsbruin, venige cultuurlaag, mosselschelp
- Slib, sterk veenhoudend, zwak houtskoolhoudend, donkerbruin, venige cultuurlaag, bovenin houtskoolspikkels
- Hiaat
- Veen, zwak kleïïg, bruin, Enkele kleivlekjes, veraard
- Veen, mineraalarm, sporen hout, bruin
- Veen, mineraalarm, bruin, gelaagd, licht riethoudend
- Veen, mineraalarm, bruin, Los stuk hout op 6,50m

Boring: 034 - 2

X: 108572,76
Y: 447447,3
z: -0,02m NAP

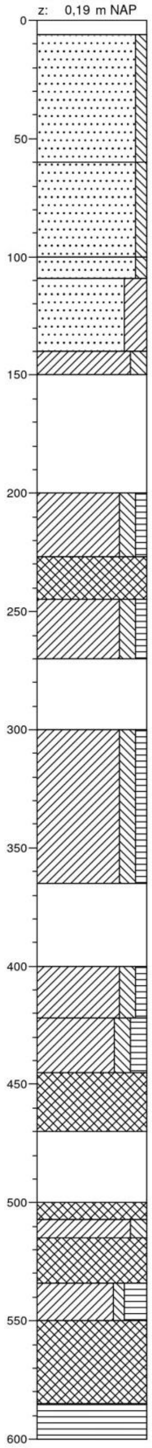


- Veen, mineraalarm, bruin, Los stuk hout op 6,50m
- Veen, mineraalarm, donkerbruin, mosveen?
- Veen, mineraalarm, geelbruin, Matig riethoudend
- Veen, mineraalarm, bruin
- Klei, zwak siltig, bruingrijs
- Veen, mineraalarm, bruin, Geleidlijke ondergrens
- Veen, zwak kleïïg, donkerbruin
- Klei, zwak siltig, matig humeus, grijsbruin, Vlekkerige laklaag
- Klei, matig siltig, bruingrijs, Enkele humusvlekjes
- Klei, matig siltig, matig humeus, donker grijsbruin, Vlekkerige laklaag
- Klei, matig siltig, bruingrijs

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 035

X: 108605,65
Y: 447566,36
z: 0,19 m NAP



Grijs, tegel

Zand, matig grof, zwak siltig, geelbruin

Zand, uiterst fijn, zwak siltig, zwak puinhoudend, grijs

Zand, uiterst fijn, zwak siltig, bruingeel

Zand, uiterst fijn, kleiïg, sterk puinhoudend, grijsbruin, rommelig bouwpuin? betonresten

Klei, matig siltig, zwak grindhoudend, sporen baksteen, licht grijsbruin

Hiaat

Klei, matig siltig, zwak humeus, licht grijsbruin, donkere humeuze vlekken

Slib, donker zwartbruin, venige cultuur/ophooglaag

Klei, matig siltig, zwak humeus, sporen baksteen, bruingrijs, donkere humeuze vlekjes

Hiaat

Klei, matig siltig, zwak humeus, zwak houtskoolhoudend, lichtbruin, houtskool brokje op 326 cm, houtskool laagje 357 cm

Hiaat

Klei, matig siltig, zwak humeus, zwak roesthoudend, bruingrijs

Klei, matig siltig, matig humeus, sporen puin, grijsbruin, kleibrokken, vlekkerige ophooglaag

Slib, zwart, venige ophooglaag met kalkrijke kleibrokjes

Hiaat

Slib, zwart, veenbrok?

Klei, matig siltig, grijs, kalkrijk, kleibrok?

Slib, donker bruinbruin, venige ophooglaag

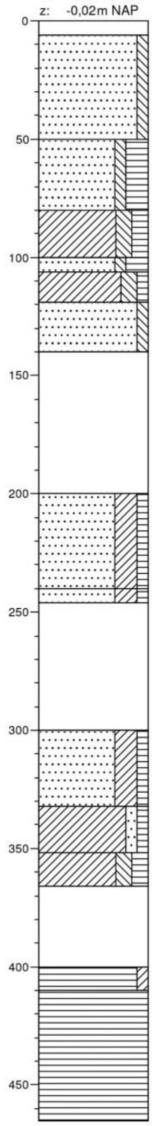
Klei, zwak siltig, sterk humeus, zwak schelphoudend, bruingrijs, mestig, gelaagd slootbodem? ophoogbrok?

Slib, zwak puinhoudend, zwak houtskoolhoudend, donker grijsbruin, venige cultuurlaag, zeven

Veen, mineraalarm, bruin

Boring: 036

X: 108721,3
Y: 447487,71
z: -0,02m NAP



Grijs, tegel

Zand, uiterst fijn, zwak siltig, sterk puinhoudend, bruingeel, betonpuin

Zand, uiterst fijn, zwak siltig, sterk humeus, donkergrijs, nat, slap

Klei, matig siltig, matig humeus, donkergrijs, plastic, verrommeld

Zand, matig grof, zwak siltig, sterk humeus, donkergrijs

Klei, matig siltig, zwak humeus, grijs, donkergrijs vlekkerig nat, slap

Zand, uiterst fijn, zwak siltig, sterk puinhoudend, donkergrijs, v36.1 dakpan, natuursteen

Hiaat

Zand, uiterst fijn, kleiïg, zwak humeus, grijsbruin, v36.2 aw

Zand, uiterst fijn, kleiïg, zwak humeus, grijsbruin

Hiaat

Zand, uiterst fijn, kleiïg, zwak humeus, grijsbruin, v36.3 aardewerk, glas, bot

Klei, zwak zandig, zwak humeus, bruingrijs, veen/turfbrokjes

Klei, matig siltig, matig humeus, donkergrijs, v36.4 leer

Hiaat

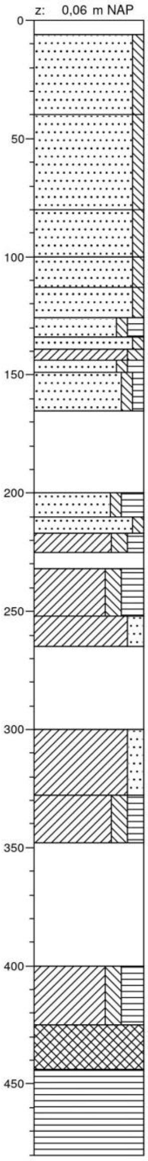
Veen, zwak kleiïg, donker bruinbruin

Veen, mineraalarm, zwak houthoudend, bruin

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 037

X: 108670,09
Y: 447455,91
z: 0,06 m NAP



Paars, klinker

Zand, matig grof, zwak siltig, geelbruin

Zand, uiterst fijn, zwak siltig, uiterst puinhoudend, grijs, betonpuin, repac

Zand, uiterst fijn, zwak siltig, zwak puinhoudend, grijs

Zand, uiterst fijn, zwak siltig, grijsgeel

Zand, uiterst fijn, zwak siltig, uiterst puinhoudend, roodwit, volledig puin

Zand, uiterst fijn, zwak siltig, matig humeus, sporen puin, donker bruingrijs

Zand, uiterst fijn, zwak siltig, lichtgrijs

Klei, matig siltig, licht grijsbruin

Zand, uiterst fijn, zwak siltig, matig humeus, donkergrijs

Zand, uiterst fijn, zwak siltig, zwak humeus, bruingrijs, wortels, humeuze vlekjes

Hiaat

Zand, uiterst fijn, zwak siltig, sterk humeus, zwak puinhoudend, donkergrijs, vlekkerig

Zand, uiterst fijn, zwak siltig, uiterst puinhoudend, roodgeel, ijsselsteenpuin, dakpan

Klei, matig siltig, matig humeus, matig veenhoudend, grijsbruin

Roodgeel, volledig puin + mortel

Klei, matig siltig, sterk humeus, matig veenhoudend, matig puinhoudend, donker bruingrijs, kleiige cultuurlaag

Klei, matig zandig, matig houtskoolhoudend, donkergrijs, as/brandlaagje onderin 1 brok puin

Hiaat

Klei, matig zandig, zwak puinhoudend, zwartgrijs, 7 laagjes ca. 4 cm klei/zand/veen

Klei, matig siltig, matig humeus, matig veenhoudend, matig schelphoudend, donker grijsbruin, kleiige cultuurlaag, v37.1 bot, zeven

Hiaat

Klei, matig siltig, sterk humeus, zwak puinhoudend, groenbruin, mestig, grijze kleivlekjes zeven

Slib, donker zwartbruin, v37.2 aardewerk, bot

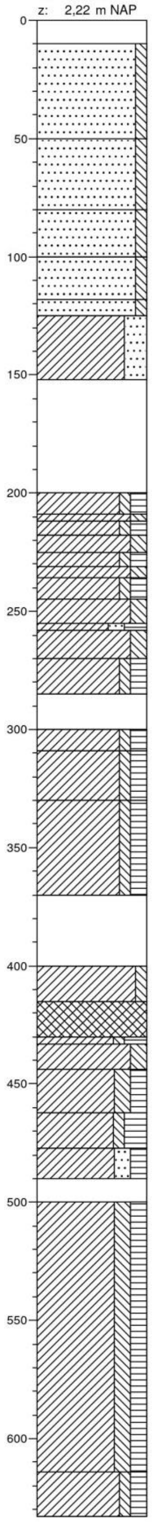
Veen, mineraalarm, sporen puin, zwak schelphoudend, donkerbruin, venige cultuurlaag, zeven?

Veen, mineraalarm, bruin

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 038 - 1

X: 108635,36
Y: 446932
z: 2,22 m NAP



Paars, klinker

Zand, matig grof, zwak siltig, zwak puinhoudend, bruingeel

Zand, uiterst fijn, zwak siltig, matig puinhoudend, licht geelbruin, ijsselsteenpuin, mortel

Zand, uiterst fijn, zwak siltig, matig puinhoudend, bruingeel, rood baksteenpuin

Zand, matig grof, zwak siltig, zwak puinhoudend, geelbruin

Zand, uiterst fijn, zwak siltig, zwak puinhoudend, licht witbruin, cement/mortel

Klei, sterk zandig, sterk puinhoudend, grijs, rode baksteen en cement

Hiaat

Klei, zwak siltig, matig humeus, matig puinhoudend, matig veenhoudend, donker bruingrijs

Klei, matig siltig, grijs

Klei, zwak siltig, matig humeus, grijsbruin, vlekkerig, straatnivo

Klei, matig siltig, grijs

Klei, zwak siltig, matig humeus, donker grijsgrijs, vlekkerig, straatnivo?

Klei, matig siltig, grijs

Klei, zwak siltig, matig humeus, grijsbruin, vlekkerig, straatniveau

Klei, matig siltig, grijs

Klei, matig zandig, sterk humeus, zwart, straatniveau?

Klei, matig siltig, grijs

Klei, zwak siltig, matig humeus, grijsbruin, vlekkerig, straatniveau?

Hiaat

Klei, zwak siltig, matig humeus, matig puinhoudend, grijsbruin, vlekkerig, straatniveautje?

Klei, zwak siltig, matig humeus, zwak veenhoudend, grijsbruin, klei-/ en veenbrokken/brokjes

Klei, zwak siltig, matig humeus, grijsbruin, enkele lichte kleivlekken/laagjes?

Hiaat

Klei, zwak siltig, sterk veenhoudend, donker bruinbruin

Slib, zwart, veenbrok/turf

Klei, zwak siltig, sterk humeus, donker zwartgrijs

Klei, matig siltig, bruingrijs

Klei, matig siltig, matig humeus, zwak plantenhoudend, grijsbruin, donkere top/plag??

Klei, zwak siltig, sterk humeus, matig veenhoudend, grijsbruin

Klei, matig zandig, matig humeus, zwak veenhoudend, grijsbruin, zandige kleibrokken?

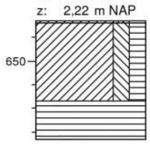
Hiaat

Klei, matig siltig, matig humeus, zwak veenhoudend, zwak houthoudend, zwak roesthoudend, grijsbruin, gele zandige vlekjes, nat/ antropogeen??

Klei, zwak siltig, matig humeus, matig houthoudend, matig veenhoudend, bruingrijs, vlekkerig nat/antropogeen??

Boring: 038 - 2

X: 108635,36
Y: 446932
z: 2,22 m NAP



Klei, zwak siltig, matig humeus, matig houthoudend, matig veenhoudend, bruingrijs, vlekkerig nat/antropogeen??

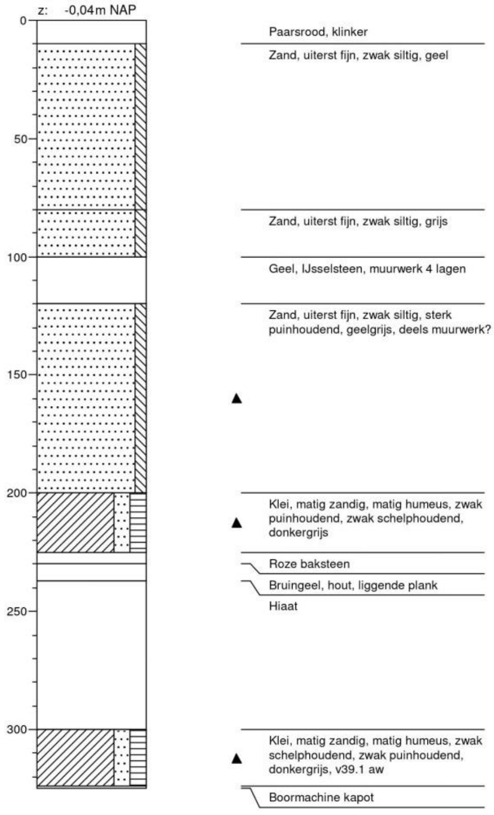
Klei, matig siltig, matig humeus, grijsbruin, bovenin grijze vlekken

Veen, mineraalarm, bruin, geleidelijke overgang

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

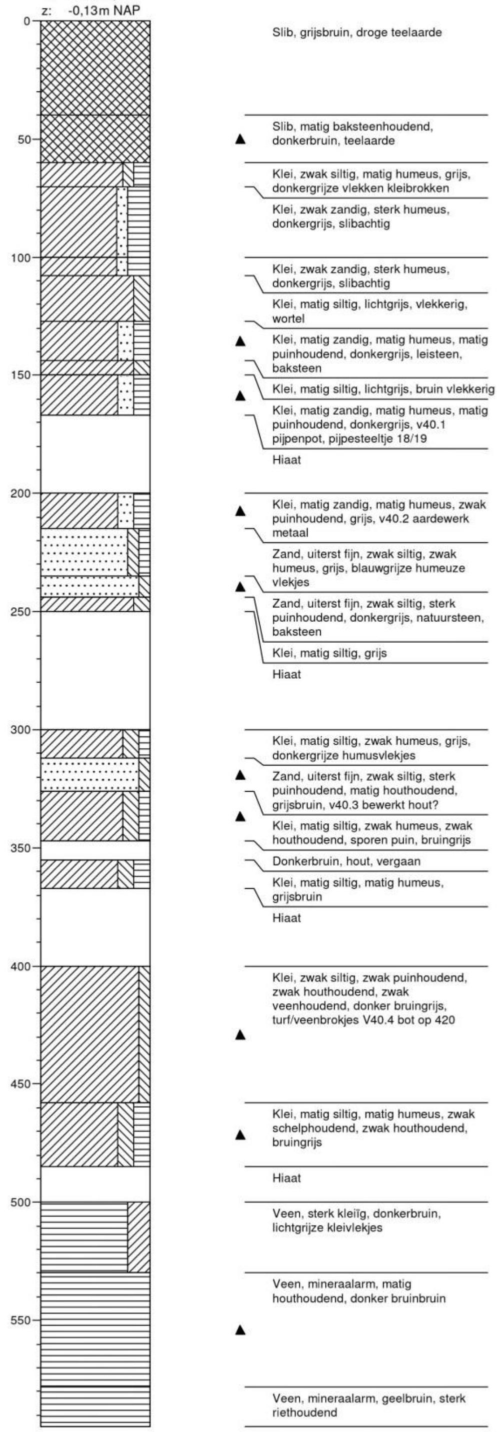
Boring: 039

X: 108132,07
Y: 447266,93
z: -0,04m NAP



Boring: 040

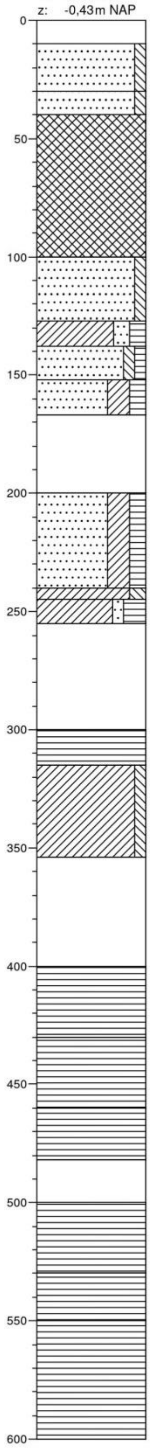
X: 108136,46
Y: 447346,96
z: -0,13m NAP



Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 041

X: 108244,46
Y: 447178,53
z: -0,43m NAP



Paars, klinker

Zand, uiterst fijn, zwak siltig, bruingeel

Zand, uiterst fijn, zwak siltig, zwak teelaardehoudend, grijs

Slib, zwak baksteenhoudend, bruin, opgebracht veen/teelaarde + brokken k/z

Zand, uiterst fijn, zwak siltig, licht bruingrijs, iets gelaagd, 2 stenen

Klei, matig zandig, matig humeus, sporen puin, grijsbruin, pijpesteeltje 18/19e eeuw

Zand, uiterst fijn, zwak siltig, zwak humeus, sporen puin, bruingrijs, iets gelaagd

Zand, uiterst fijn, kleïig, matig humeus, grijsbruin, boven- en onderkant laagje puin

Hiaat

Zand, uiterst fijn, kleïig, matig humeus, matig puinhoudend, bruingrijs

Klei, matig siltig, grijs, kleibrok?

Klei, zwak zandig, sterk humeus, zwak puinhoudend, donkergrijs, leisteen, baksteen

Hiaat

Veen, mineraalarm, matig houthoudend, bruin, veenbrok? bovenin ingelopen zand

Klei, zwak siltig, matig veenhoudend, matig houthoudend, grijsbruin

Hiaat

Veen, mineraalarm, zwak houthoudend, groenbruin, matig riethoudend

Veen, mineraalarm, zwak houthoudend, bruin

Veen, mineraalarm, groenbruin, matig riethoudend

Hiaat

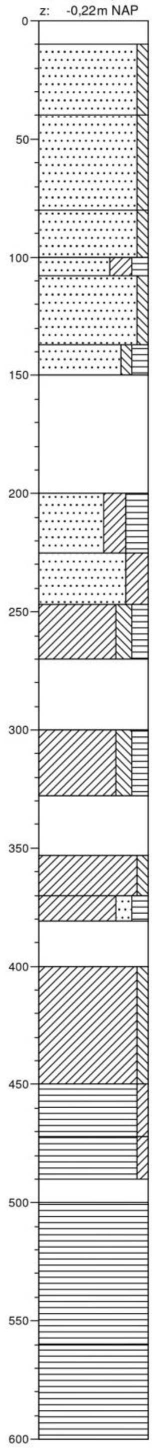
Veen, mineraalarm, geelbruin, sterk riethoudend

Veen, mineraalarm, sterk houthoudend, roodbruin

Veen, mineraalarm, zwak houthoudend, bruin

Boring: 042

X: 108451,52
Y: 447153,85
z: -0,22m NAP



Paars, klinker

Zand, uiterst fijn, zwak siltig, uiterst teelaardehoudend, sterk puinhoudend, zwart

Zand, uiterst fijn, zwak siltig, zwak roesthoudend, bruingeel

Zand, uiterst fijn, zwak siltig, matig puinhoudend, bruingeel

Zand, uiterst fijn, kleïig, matig humeus, sporen puin, donkergrijs

Zand, uiterst fijn, zwak siltig, roodgeel, volledig puin+ mortel muurwerk?

Zand, uiterst fijn, zwak siltig, matig humeus, matig houthoudend, bruingrijs, funderingshout?

Hiaat

Zand, uiterst fijn, kleïig, sterk humeus, matig puinhoudend, zwak schelphoudend, donker zwartgrijs, leisteen geelroze baksteen

Zand, uiterst fijn, kleïig, sterk puinhoudend, grijs, rozerode baksteen, mortel

Klei, matig siltig, matig humeus, matig veenhoudend, zwak houthoudend, donker zwartgrijs, gelaagd/brokken klei/veen

Hiaat

Klei, matig siltig, matig humeus, matig veenhoudend, zwak houthoudend, donker zwartgrijs, gelaagd/brokken klei/veen

Hout. hard, ca. 20 minuten op geboord

Klei, zwak siltig, sterk veenhoudend, donker bruingrijs, venige cultuurlaag, v42.1 leer,

Klei, matig zandig, matig humeus, matig houtskoolhoudend, grijsgrijs, as/cultuurlaag, zeven

Hiaat

Klei, zwak siltig, uiterst veenhoudend, donker grijsgrijs, grijze vlekjes met houtskool? zeven?

Veen, zwak kleïig, matig houthoudend, donker grijsbruin, matig riethoudend

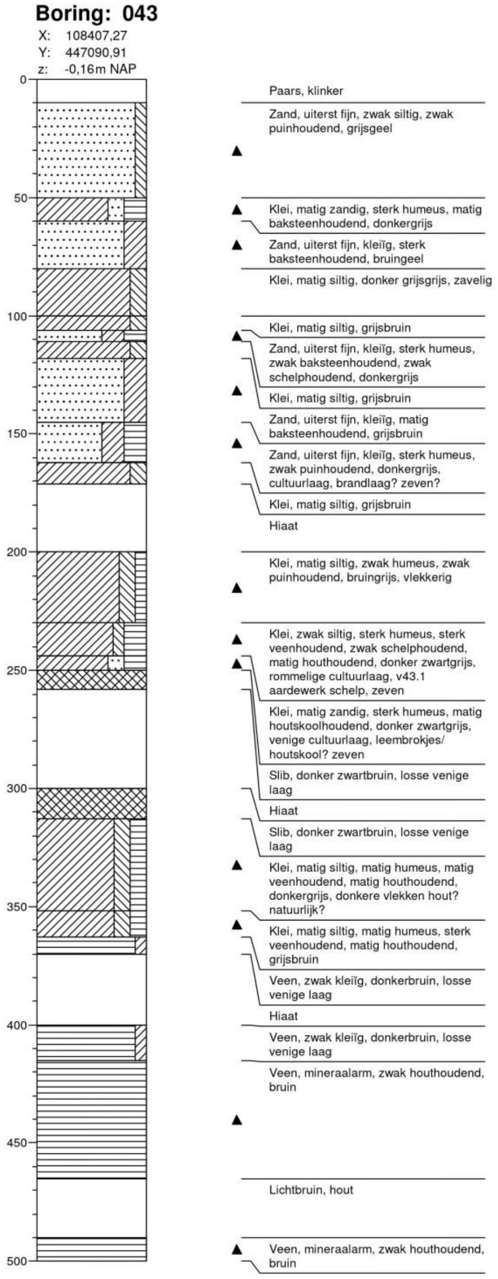
Veen, zwak kleïig, grijsbruin, brok licht klei/laagje klapklei?

Hiaat

Veen, mineraalarm, zwak houthoudend, roodbruin, groot stuk hout op 520 cm

Veen, mineraalarm, bruin, matig riethoudend

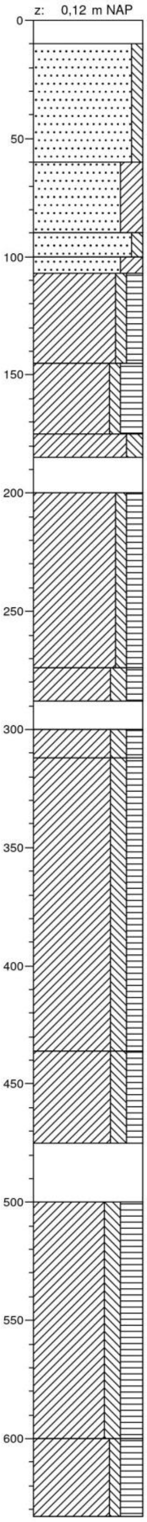
Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I



Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 044 - 1

X: 108347,76
Y: 447054,17
z: 0,12 m NAP



Paars, klinker

Zand, uiterst fijn, zwak siltig, zwak roesthoudend, lichtbruin

Zand, uiterst fijn, kleiïg, zwak puinhoudend, grijsbruin, rood baksteenpuintjes, mortel

Zand, uiterst fijn, zwak siltig, grijsbruin

Zand, uiterst fijn, kleiïg, lichtbruin

Klei, zwak siltig, matig humeus, matig veenhoudend, sporen baksteen, grijsbruin, veenbrokjes+ 1 groot brok op 115-120 cm

Klei, zwak siltig, sterk humeus, donker grijsgrijs, brokkelig/ vlekkerig, scherpe bodem

Klei, matig siltig, matig houthoudend, grijs, vlekkerig, brok hout

Hiaat

Klei, zwak siltig, matig humeus, zwak houthoudend, bruingrijs, vlekkerig, kalkloos, takken op 272 cm

Klei, matig siltig, matig humeus, grijs, egaal, kalkloos

Hiaat

Klei, matig siltig, matig humeus, grijsbruin, egaal, kalkloos

Klei, matig siltig, matig humeus, bruingrijs, matig kalkrijk lichte bruinbeige banden,

Klei, matig siltig, matig humeus, grijsbruin, vrij egaal, kalkloos, onderin licht kalkhoudend

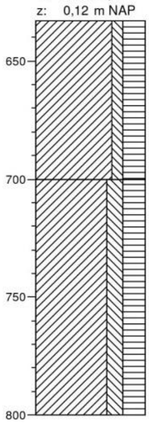
Hiaat

Klei, matig siltig, sterk humeus, donkergrijs, enkele kleine beige vlekken, licht kalkhoudend

Klei, zwak siltig, sterk humeus, donker bruingrijs, enkele lichte banden 4-5 cm, licht kalkhoudend

Boring: 044 - 2

X: 108347,76
Y: 447054,17
z: 0,12 m NAP



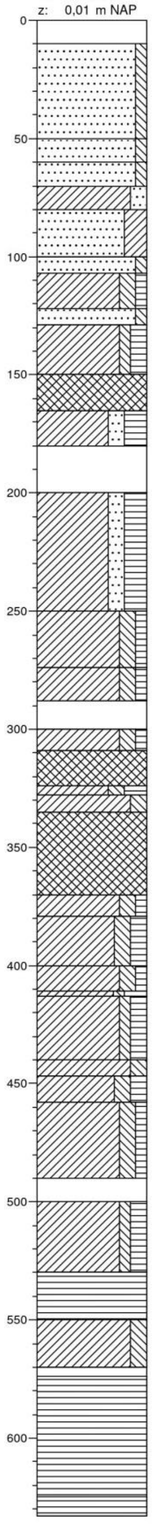
Klei, zwak siltig, sterk humeus, donker bruingrijs, enkele lichte banden 4-5 cm, licht kalkhoudend

Klei, matig siltig, sterk humeus, donkergrijs, licht kalkhoudend

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 045 - 1

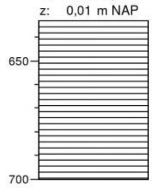
X: 108310,09
Y: 447028,5
z: 0,01 m NAP



Paars, klinker
Zand, uiterst fijn, zwak siltig, zwak puinhoudend, bruingeel
Zand, uiterst fijn, zwak siltig, uiterst puinhoudend, rood, mortelhoudend
Zand, uiterst fijn, zwak siltig, zwak puinhoudend, bruingeel
Klei, matig zandig, zwak puinhoudend
Zand, uiterst fijn, kleiïg, sterk puinhoudend, grijs, veel mortel onderste deel zwart humeus
Zand, uiterst fijn, zwak siltig, matig puinhoudend, bruinoranje
Klei, matig siltig, zwak humeus, lichtgrijs, donkergrijze humeuze vlekken
Zand, uiterst fijn, zwak siltig, uiterst puinhoudend, rood, 1 brok puin
Klei, zwak siltig, matig humeus, zwak puinhoudend, bruingrijs, humeus vlekkerig met baksteenpuintjes
Slib, zwak puinhoudend, zwart, venige cultuurlaag
Klei, matig zandig, sterk humeus, zwak houtskoolhoudend, sporen puin, licht bruingrijs, fijne laagjes/ brokken klei/veen
Hiaat
Klei, matig zandig, sterk humeus, zwak houtskoolhoudend, sporen puin, licht bruingrijs, fijne laagjes/ brok klei/veen v45.1 208 cm
Klei, matig siltig, zwak humeus, bruingrijs, kalkrijk, 2 zwarte bandjes op 255 cm en 262 cm
Klei, matig siltig, zwak humeus, zwak houthoudend, zwak veenhoudend, grijsbruin, kalkloos
Hiaat
Klei, matig siltig, zwak humeus, lichtgrijs, 1 humeus bandje
Slib, matig houthoudend, venige cultuurlaag
Klei, matig siltig, sterk humeus, zwak houtskoolhoudend, sporen baksteen, donkergrijs
Klei, matig siltig, grijs, kleibrok? kalkrijk
Slib, zwak houthoudend, donker grijsbruin, venige cultuurlaag, kleine lichtgrijze kleivlekjes v45.2 aardewerk
Klei, matig siltig, zwak humeus, bruingrijs, licht kalkrijk
Klei, matig siltig, matig humeus, zwak houthoudend, zwak schelphoudend, grijsbruin, kalkloos donkere humeuze vlekjes/hout/
Klei, matig siltig, zwak humeus, bruingrijs, kalkhoudned, vlekkerig, bovenin ingevallen puintjes
Klei, zwak siltig, sterk humeus, donkergrijs, slibachtig
Klei, zwak siltig, matig humeus, matig veenhoudend, zwak houthoudend, zwak houtskoolhoudend, grijsbruin, 1 veenbrok, v45.2 kalkloos
Klei, matig siltig, lichtgrijs, kalkloos
Klei, matig siltig, matig humeus, grijsbruin, kalkloos, licht vlekkerig
Klei, matig siltig, zwak humeus, grijs, kalkloos iets vlekkerig, roestsporen?
Hiaat
Klei, zwak siltig, matig humeus, sterk veenhoudend, zwak houthoudend, grijsbruin, kalkloos
Veen, mineraalarm, matig houthoudend, donkerbruin, geleidelijke boven- en ondergrens
Klei, matig siltig, sporen hout, bruingrijs
Bruin, hout
Veen, mineraalarm, zwak houthoudend, bruin
Veen, mineraalarm, bruin, matig riethoudend

Boring: 045 - 2

X: 108310,09
Y: 447028,5
z: 0,01 m NAP

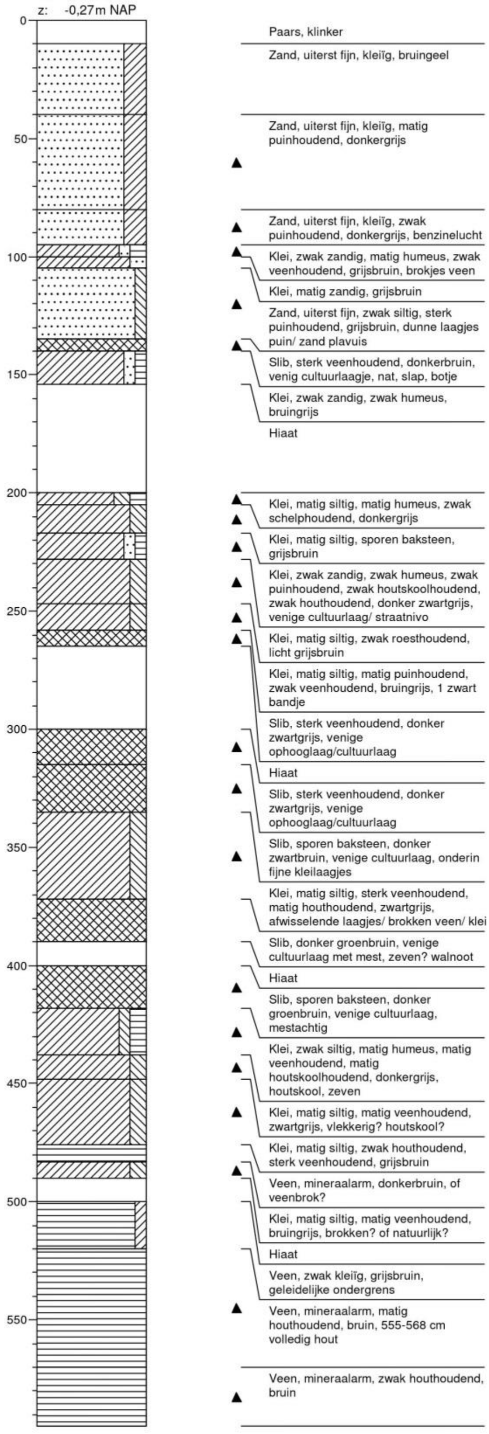


Veen, mineraalarm, bruin, matig riethoudend

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

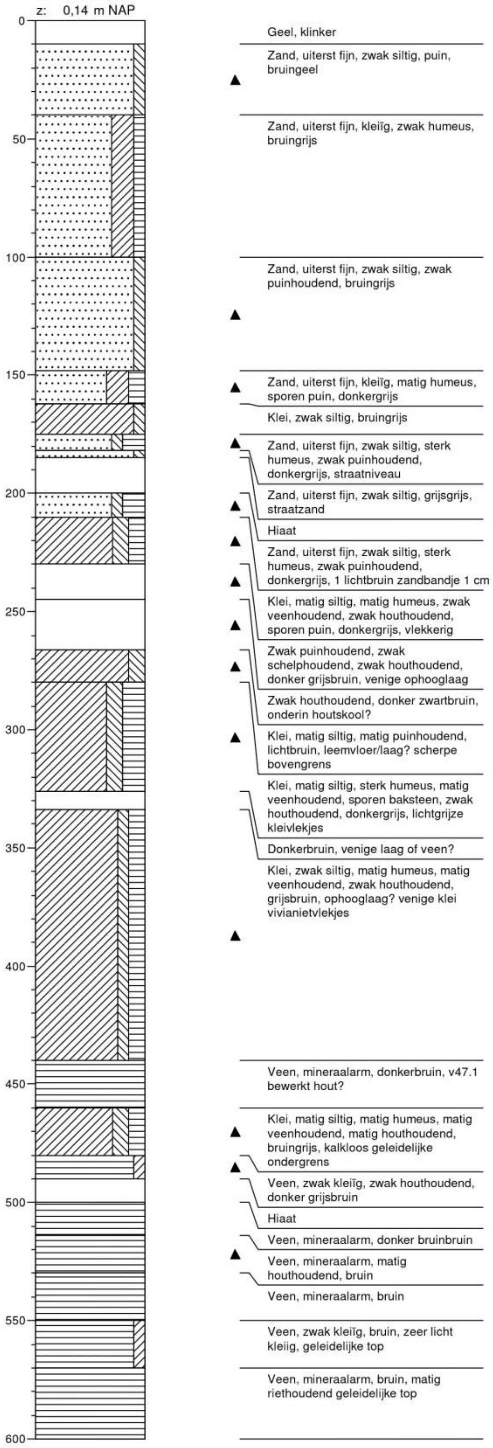
Boring: 046

X: 108282,67
Y: 447001,22
z: -0,27m NAP

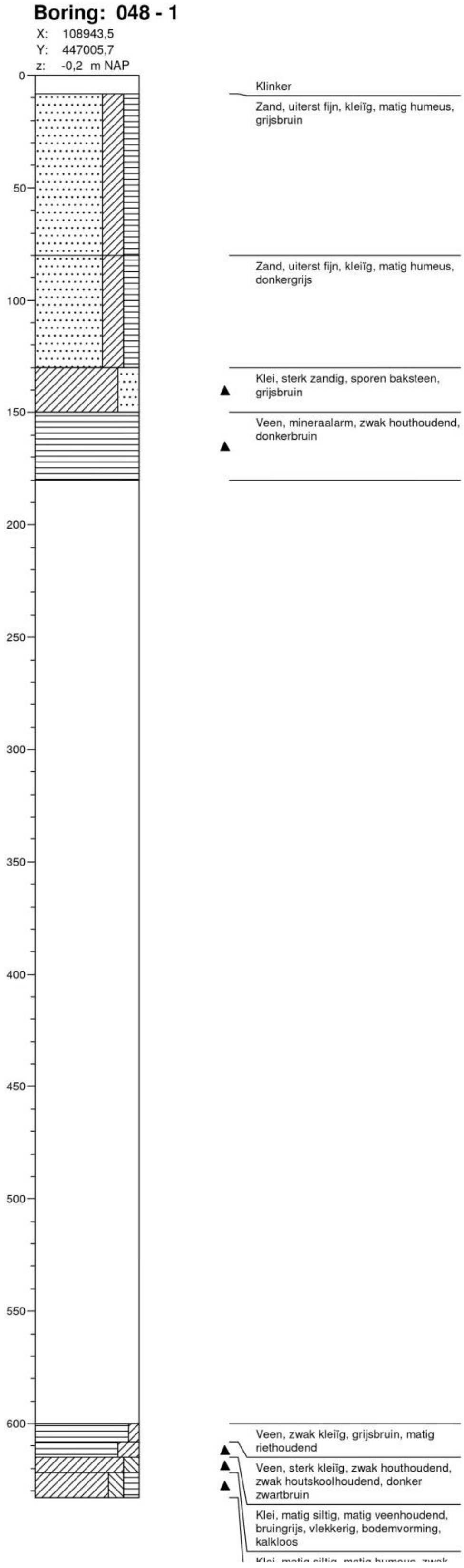


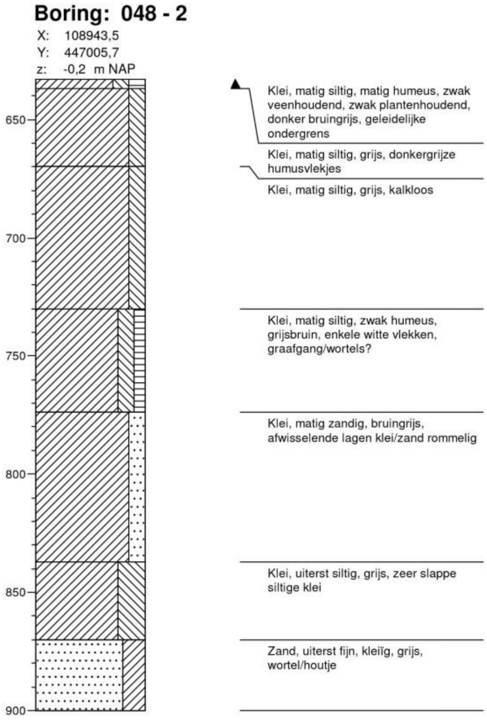
Boring: 047

X: 108389,65
Y: 446979,54
z: 0,14 m NAP



Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

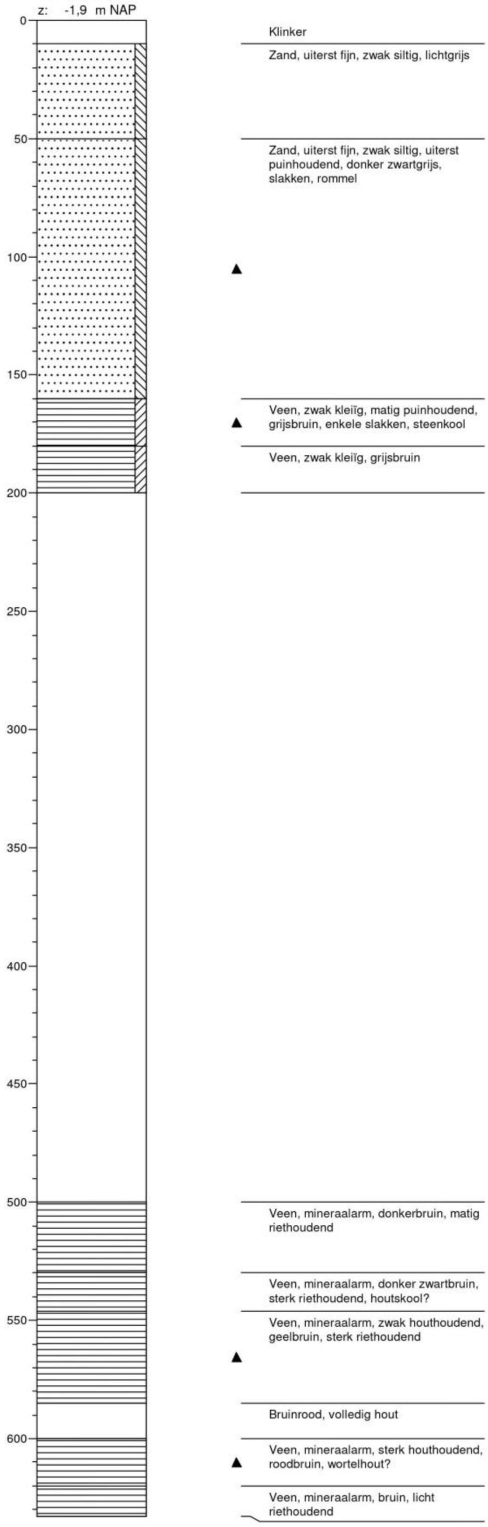




Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

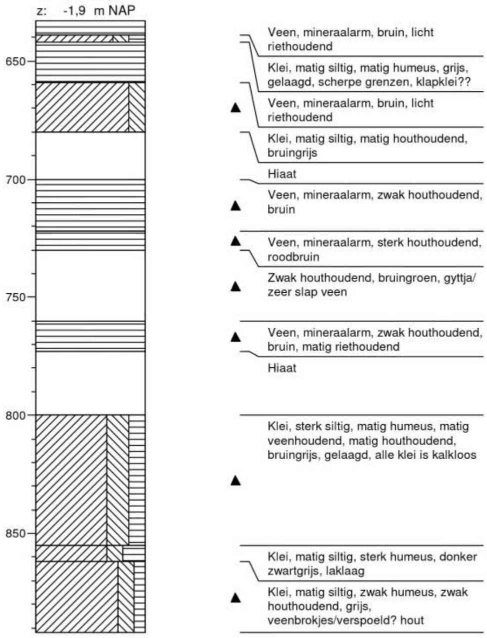
Boring: 049 - 1

X: 108621,8
Y: 447871,2
z: -1,9 m NAP



Boring: 049 - 2

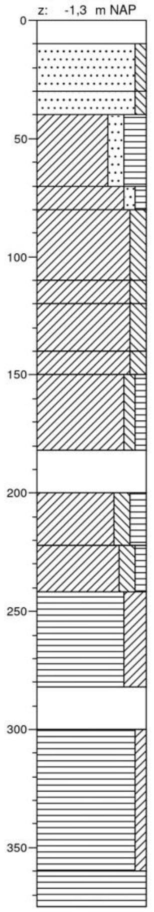
X: 108621,8
Y: 447871,2
z: -1,9 m NAP



Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 050

X: 108865,8
Y: 447622,6
z: -1,3 m NAP



Klinker

Zand, uiterst fijn, zwak siltig, bruingeel

Zand, uiterst fijn, zwak siltig, grijs

Klei, matig zandig, sterk humeus, zwak baksteenhoudend, donker bruingrijs, pijpesteel, stukje pijpekop 18/19

Klei, zwak zandig, zwak humeus, matig puinhoudend, bruingrijs, baksteen, daktegel? monster

Klei, matig siltig, blauwgrijs, zeer stug.

Klei, matig siltig, grijs, baksteenspikkel, vrijwel kalkloos

Klei, matig siltig, grijs, licht kalkhoudend

Klei, matig siltig, matig roesthoudend, bruingroen, matig kalkhoudend

Klei, zwak siltig, zwak humeus, zwak veenhoudend, grijsbruin, iets gelaagde humus matig kalkhoudend

Hiaat

Klei, matig siltig, matig humeus, grijsbruin

Klei, matig siltig, zwak humeus, zwak houthoudend, bruingrijs, geleidelijke ondergrens

Veen, sterk kleiïg, grijsbruin, fijngelaagd, kleine worteltjes

Hiaat

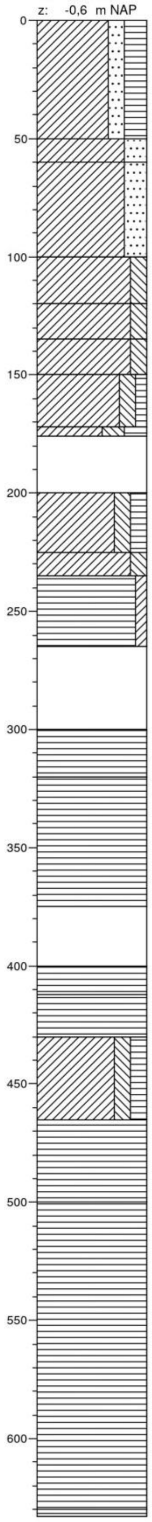
Veen, zwak kleiïg, grijsbruin, fijn veen, matig riethoudend

Veen, mineraalarm, bruin, geleidelijke bovengrens

Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Boring: 051 - 1

X: 108816,5
Y: 446515,1
z: -0,6 m NAP



Klei, matig zandig, sterk humeus, matig teelaardehoudend, zwak puinhoudend, donker grijsbruin

Klei, sterk zandig, sterk puinhoudend, grijs, gele en roze baksteen

Klei, sterk zandig, sterk puinhoudend, grijs, gele en roze baksteen

Klei, matig siltig, zwak roesthoudend, zwak baksteenhoudend, grijsbeige

Klei, matig siltig, zwak houthoudend, zwak veenhoudend, bruingrijs, kleine humus-, lichtgrijze kalkvlekjes

Klei, matig siltig, matig houthoudend, zwak houtskoolhoudend, bruingrijs, sterk vlekkerig, gelaagd monster

Klei, matig siltig, zwak humeus, zwak houthoudend, zwak veenhoudend, bruingrijs, licht kalkhoudend kleine vlekjes

Klei, sterk siltig, sterk humeus, donker grijsgrijs, zeer humeus laagje of houtskool?

Hiaat

Klei, matig siltig, matig humeus, zwak houthoudend, zwak houtskoolhoudend, donker bruingrijs, cultuurlaag, monster, vivianietvlekjes v51.2 aw

Klei, matig siltig, zwak houthoudend, bruingrijs

Veen, zwak kleïg, zwak houtskoolhoudend, donker bruinbruin, v51.3 houtskool

Hiaat

Veen, mineraalarm, matig houtskoolhoudend, donkerbruin, v51.4

Veen, mineraalarm, zwak houthoudend, bruin

Hiaat

Veen, mineraalarm, sterk houthoudend, bruin

Veen, mineraalarm, matig houthoudend, bruin, matig riethoudend, geleidelijke grenzen

Klei, matig siltig, matig humeus, matig veenhoudend, bruingrijs, matig/sterk riethoudend

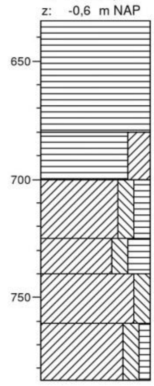
Veen, mineraalarm, bruin, matig riethoudend

Veen, mineraalarm, zwak houthoudend, bruin, licht riethoudend

Veen, mineraalarm, bruin, matig/srerk riethoudend

Boring: 051 - 2

X: 108816,5
Y: 446515,1
z: -0,6 m NAP



Veen, mineraalarm, bruin, matig/srerk riethoudend

Veen, sterk kleïg, matig houthoudend, grijsbruin

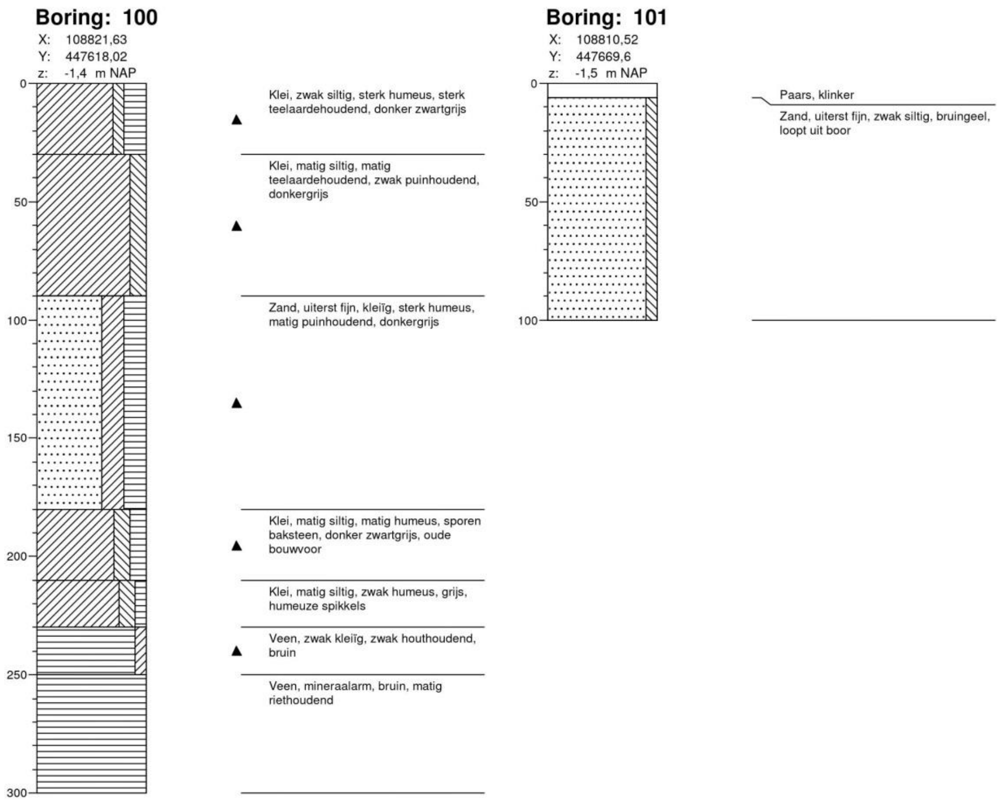
Klei, matig siltig, matig humeus, zwak veenhoudend, zwak houthoudend, donker grijsgrijs, vlekkerig kalkloos

Klei, matig siltig, sterk humeus, donkergrijs, laklaag, onderin lichte vlekjes, kalkloos

Klei, matig siltig, bruingrijs, iets vlekkerig, kalkloos

Klei, matig siltig, zwak humeus, zwak houthoudend, grijsbruin, vlekkerig, licht kalkhoudend

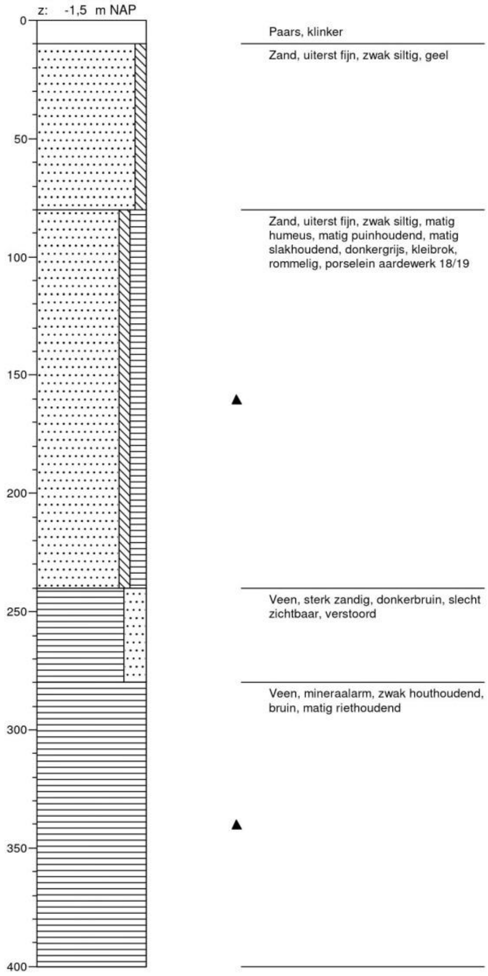
Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I



Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

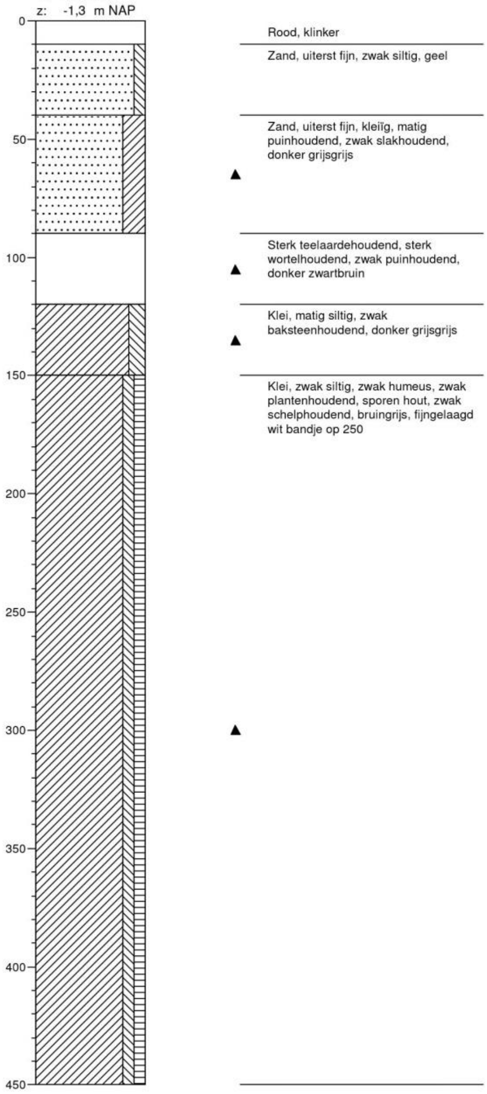
Boring: 102

X: 108761,66
Y: 447572,77
z: -1,5 m NAP

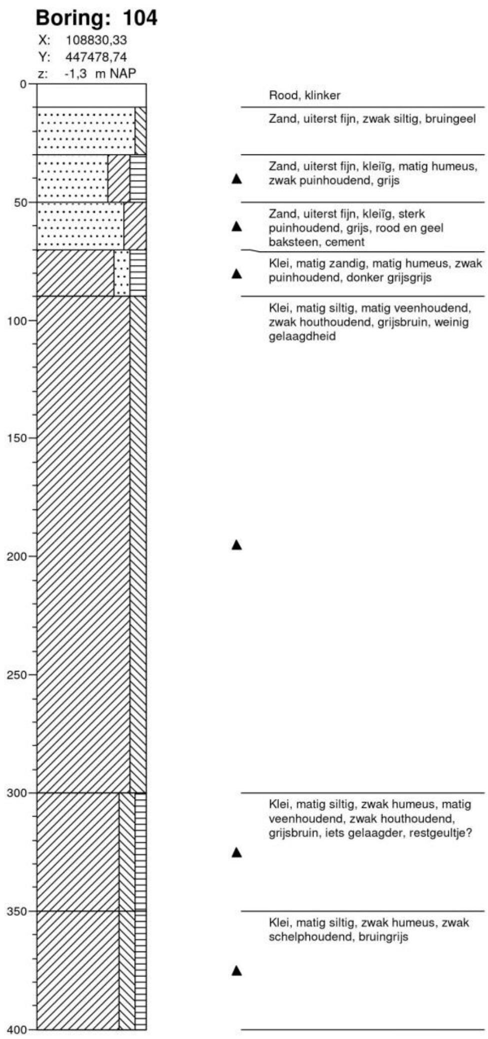


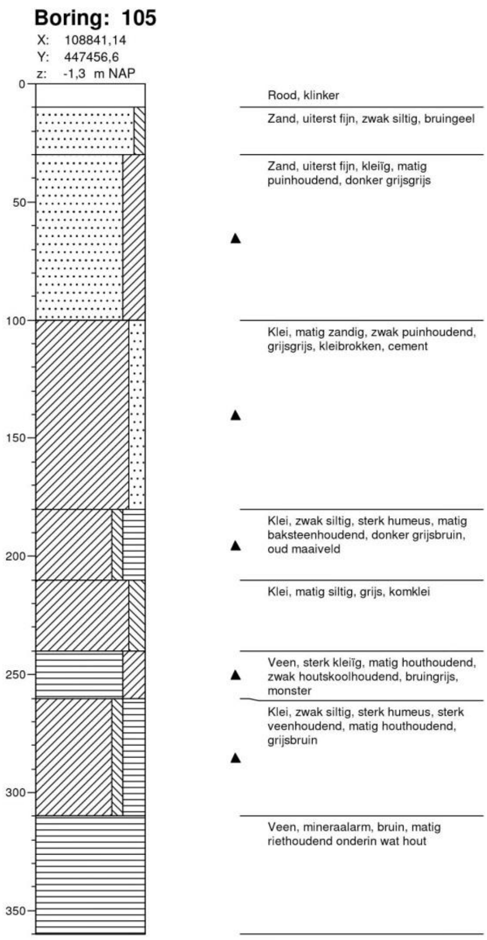
Boring: 103

X: 108817,01
Y: 447504
z: -1,3 m NAP



Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I





Projectnaam: Binnenstad Gouda
Projectcode: A12-041-I

Appendix 6: core descriptions of the cores executed during the fieldwork accompanying this research.

Universiteit Utrecht

B001

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 108443
Y-coordinaat (m)	: 447414
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: -12
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 1160
Datum boring	: 23-1-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: 1e boring. In boomspiegel naast parkeersplaats. Verwachte diepte van het veen: 4-5 m-mv.

Boormethode

Diepte (cm)	Omschrijving
0 - 160	Edelmanboring
160 - 1160	Guts

Lithologie

Grondwater na boren (cm - mv)	: 100
Gem. hoogste grondwaterstand (cm - mv)	: 60
Gem. laagste grondwaterstand (cm - mv)	: 140

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 20	klei	zwak zandig, sterk humeus, donker-bruin-grijs, wortels		
20 - 30	klei	zwak zandig, donker-bruin-grijs, wortels, kleibrokjes, Opm.: monster M4		
30 - 40	klei	zwak zandig, zwak grindig, donker-bruin-grijs, wortels, kleibrokjes		
40 - 50	klei	zwak zandig, sterk grindig, donker-bruin-grijs, plantenresten, wortels, kleibrokjes		
50 - 60	klei	sterk siltig, matig grindig, matig humeus, donker-bruin-grijs, plantenresten, kalkconcreties, baksteen, Opm.: baksteen 3cm		
60 - 70	klei	sterk siltig, zwak grindig, matig humeus, donker-bruin-grijs, plantenresten, kalkconcreties		
70 - 80	klei	uiterst siltig, matig humeus, bruin-grijs, plantenresten, kalkconcreties, Opm.: enkel grindje		
80 - 90	klei	uiterst siltig, zwak grindig, zwak humeus, bruin-grijs, plantenresten, kalkconcreties		
90 - 100	klei	uiterst siltig, zwak grindig, zwak humeus, bruin-grijs, plantenresten, veel kalkconcreties		
100 - 110	klei	uiterst siltig, zwak humeus, donker-grijs, kalkconcreties, Opm.: grovere bijmenging		
110 - 120	klei	uiterst siltig, grindig, geel-grijs, Opm.: Monster M1		
120 - 130	leem	sterk zandig, grijs-geel, kalkconcreties, baksteen, Opm.: Monster M5		
130 - 140	leem	sterk zandig, geel-grijs, kalkconcreties, spoor veenbrokjes, Opm.: slakje en grind, reductie		
140 - 150	klei	sterk siltig, grijs, kalkconcreties, spoor ijzeroxide, spoor veenbrokjes, spoor baksteen, Opm.: grindje, reductie		
150 - 160	klei	matig siltig, grijs, weinig zwarte vlekken, spoor ijzeroxide, Opm.: tand, Monster M2		
160 - 170	klei	matig siltig, donker-grijs, spoor ijzeroxide, spoor ijzeroxide, kalkconcreties, spoor veenbrokjes, Opm.: # compact, zwart onderin		
170 - 180	klei	matig siltig, licht-bruin-grijs, spoor ijzeroxide, weinig veenbrokjes		
180 - 190	klei	sterk siltig, licht-bruin-grijs, spoor ijzeroxide, baksteen		
190 - 200	klei	sterk siltig, licht-bruin-grijs, plantenresten, Opm.: klein grindje		
200 - 210	klei	sterk siltig, grijs, weinig hout, spoor botresten, weinig veenbrokjes		
210 - 220	klei	sterk siltig, grijs, spoor botresten		
220 - 230	klei	sterk siltig, zandig, grijs, spoor hout, kalkconcreties		
230 - 240	klei	sterk siltig, zandig, grijs, weinig baksteen, Opm.: #		
240 - 250	klei	sterk siltig, zandig, donker-grijs, kalkconcreties, weinig veenbrokjes, Opm.: # grindje, Monster M3		
250 - 260	klei	sterk siltig, zandig, donker-grijs, kalkconcreties		
260 - 270	klei	sterk siltig, zandig, zwak humeus, donker-grijs, Schelpen: spoor schelpmateriaal, kalkconcreties, Opm.: grindjes, mossel		

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
270 - 280	klei	sterk siltig, zandig, donker-grijs, Opm.: #		
280 - 290	baksteen	oranje-grijs, Opm.: # Monster M6		
290 - 300	klei	matig siltig, licht-bruin-grijs, organisch materiaal, weinig baksteen		
300 - 310	klei	sterk siltig, licht-bruin-grijs, kalkconcreties, organisch materiaal, Opm.: stug, organische pebbels		
310 - 340	klei	sterk siltig, grijs, veel donker-grijze vlekken, organisch materiaal		
340 - 350	klei	sterk siltig, zwart-grijs, veel donker-grijze vlekken, organisch materiaal, weinig veenbrokjes, Opm.: #, onderkant blokje veen		
350 - 360	klei	zwak zandig, donker-grijs, Opm.: #		2
360 - 370	klei	uiterst siltig, zandig, donker-grijs, weinig houtresten		2
370 - 380	klei	uiterst siltig, zandig, donker-grijs, weinig houtresten		1
380 - 390	klei	sterk siltig, sterk humeus, donker-grijs		1
390 - 400	klei	zwak zandig, geel-grijs, Opm.: #		2
400 - 410	klei	matig zandig, geel-grijs, Zand: matig grof, Opm.: #		2
410 - 420	klei	uiterst siltig, licht-geel-grijs, Opm.: niet gelaagd		2
420 - 430	klei	uiterst siltig, licht-geel-grijs, Opm.: zeer siltig		2
430 - 440	klei	uiterst siltig, licht-geel-grijs, kalkconcreties, Opm.: #, licht gelaagd		
440 - 450	geen monster	Opm.: #		
450 - 460	klei	matig zandig, licht-geel-grijs, Opm.: grindje		
460 - 470	klei	uiterst siltig, licht-geel-grijs, Opm.: schone leem, Monster M7		2
470 - 480	klei	uiterst siltig, licht-geel-grijs, Opm.: baksteen 5cm, Monster M8		1
480 - 490	klei	sterk siltig, matig humeus, bruin-grijs, kalkconcreties, spoor baksteen		
490 - 500	klei	sterk siltig, matig humeus, bruin-grijs, Schelpen: spoor schelpmateriaal, kalkconcreties, spoor baksteen		
500 - 510	klei	sterk siltig, bruin-grijs, Schelpen: spoor schelpmateriaal, kalkconcreties, spoor botresten, Opm.: #		
510 - 520	grind	sterk zandig, donker-bruin-grijs, Schelpen: spoor schelpmateriaal, Opm.: #		
520 - 530	klei	sterk siltig, sterk humeus, donker-bruin-grijs, Schelpen: spoor schelpmateriaal, Opm.: fijn grindje		
530 - 540	veen	sterk kleiig, donker-grijs-bruin		
540 - 550	veen	sterk kleiig, donker-grijs-bruin, weinig kleibrokjes		
550 - 560	veen	sterk kleiig, donker-grijs-bruin, weinig kleibrokjes, Opm.: #		
560 - 570	geen monster	Opm.: #		
570 - 580	klei	matig siltig, matig humeus, bruin-grijs		
580 - 590	klei	matig siltig, sterk humeus, bruin-grijs, Opm.: blauwgrijze kleibrokjes, niet humeus		
590 - 600	veen	zwak kleiig, grijs-bruin, Veen: sterk amorf, brokkelig		
600 - 610	veen	mineraalarm, bruin, Veen: sterk amorf, brokkelig, Opm.: # compact		
610 - 620	veen	mineraalarm, geel-bruin, Veen: zwak amorf, rietveen, veel riet, Opm.: # sterk gelaagd/plaatig		
620 - 630	veen	zwak kleiig, bruin, Veen: matig amorf, weinig riet, Opm.: takjes		
630 - 640	veen	zwak kleiig, bruin, Veen: matig amorf, spoor hout, Schelpen: spoor schelpmateriaal, Opm.: zaadjes		
640 - 650	veen	zwak kleiig, bruin, Veen: matig amorf, weinig riet, Opm.: zaadjes ==> erg nat millieu		
650 - 660	veen	zwak kleiig, bruin, Veen: matig amorf, Opm.: # zaadjes		
660 - 670	veen	sterk kleiig, bruin-grijs, Veen: zwak amorf, Schelpen: spoor schelpmateriaal, Opm.: #		
670 - 680	veen	zwak kleiig, bruin-grijs, Veen: zwak amorf, Opm.: zaadjes, Monster M9		
680 - 690	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, weinig wortels, Opm.: rode tint, licht plaatig		
690 - 700	veen	mineraalarm, bruin, Veen: zwak amorf, weinig riet, weinig zegge, weinig hout, Opm.: # licht plaatig		
700 - 710	veen	mineraalarm, bruin, Veen: zwak amorf, weinig zegge, weinig riet, weinig hout, Opm.: # licht plaatig		
710 - 720	veen	mineraalarm, bruin, Veen: zwak amorf, weinig hout, weinig riet, weinig zegge, Opm.: licht plaatig		
720 - 730	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, Opm.: licht plaatig		
730 - 740	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, Opm.: iets kleiig?		
740 - 750	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen		
750 - 760	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, Opm.: #		
760 - 770	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, Opm.: # iets kleiig		
770 - 780	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, Opm.: niet meer plaatig		
780 - 810	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen		
810 - 820	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, brokkelig, Opm.: # Monster M11		

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
820 - 830	veen	mineraalarm, donker-bruin, Veen: sterk amorf, rietveen, Opm.: #		
830 - 840	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen		
840 - 850	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen		
850 - 860	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, Opm.: licht plaatig		
860 - 870	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, spoor riet		
870 - 880	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, Opm.: # licht plaatig, iets kleiig		
880 - 890	veen	zwak kleiig, donker-bruin, Veen: matig amorf, Opm.: #		
890 - 900	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen		
900 - 910	veen	mineraalarm, donker-bruin, Veen: sterk amorf, Opm.: waarschijnlijk rietveen		
910 - 914	klei	zwak siltig, zwak humeus, bruin-grijs		
914 - 920	veen	mineraalarm, donker-bruin, Veen: sterk amorf		
920 - 930	veen	zwak kleiig, donker-bruin, Veen: sterk amorf, Opm.: #		
930 - 940	veen	zwak kleiig, grijs-bruin, Veen: sterk amorf, Opm.: #		
940 - 950	veen	zwak kleiig, grijs-bruin, Veen: sterk amorf		
950 - 960	veen	zwak kleiig, grijs-bruin, Veen: sterk amorf, Opm.: stukje hout		
960 - 970	veen	sterk kleiig, bruin-grijs, Veen: sterk amorf		
970 - 980	veen	sterk kleiig, grijs-bruin, Veen: sterk amorf, Opm.: # met riet		
980 - 990	veen	zwak kleiig, grijs-bruin, Veen: sterk amorf, Opm.: #		
990 - 1000	veen	zwak kleiig, grijs-bruin, weinig riet, Opm.: Monster M12		
1000 - 1010	veen	sterk kleiig, grijs-bruin, weinig riet, Opm.: licht gelaagd		
1010 - 1020	veen	sterk kleiig, grijs-bruin, weinig riet		
1020 - 1030	klei	zwak siltig, sterk humeus, grijs, veel plantenresten, Opm.: Monster M13		
1030 - 1040	klei	zwak siltig, sterk humeus, grijs, veel plantenresten, Opm.: #		
1040 - 1050	klei	zwak siltig, matig humeus, licht-bruin-grijs, plantenresten, Opm.: # riet en zaadjes		
1050 - 1060	veen	sterk kleiig, bruin-grijs, weinig riet, weinig galigaan		
1060 - 1070	klei	zwak siltig, sterk humeus, bruin-grijs, veel plantenresten		
1070 - 1080	klei	matig siltig, zandig, donker-grijs, A-horizont, Opm.: top 5cm bodem vorming (A Horizont): h1 + gevlekt		
1080 - 1090	klei	sterk siltig, grijs, plantenresten, spoor riet, Opm.: grof zand		
1090 - 1100	klei	sterk siltig, grijs, plantenresten		
1100 - 1110	klei	sterk siltig, grijs, plantenresten, spoor hout, Opm.: #		
1110 - 1160	geen monster	Opm.: uit guts gevallen, waarschinlijk zand		

Universiteit Utrecht

B002

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 108371
Y-coordinaat (m)	: 447536
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: 20
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 1100
Datum boring	: 31-1-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Herpstraat aan de singel-zeide. Boring gedaan onder een stoeptegel naast parkeerplaatsen.

Boormethode

Diepte (cm)	Omschrijving
0 - 200	Edelmanboring
200 - 1100	Guts

Lithologie

Grondwater na boren (cm - mv)	: 150
Gem. hoogste grondwaterstand (cm - mv)	: 80
Gem. laagste grondwaterstand (cm - mv)	: 160

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 70	zand	geel, Zand: matig grof, Schelpen: spoor schelpmateriaal, spoor ijzercarbonaat, Opm.: kalkloos, opgehoogd	210-300	
70 - 80	zand	geel, Zand: matig grof, spoor ijzercarbonaat, Opm.: kalkloos, onderkant grijs	210-300	
80 - 90	zand	grijs, Zand: matig grof, Opm.: kalkloos, ijzerloos	210-300	
90 - 100	klei	zwak zandig, grijs, Zand: matig grof, kalkconcreties, Opm.: kalk- en ijzerloos, grote KAC	210-300	
100 - 150	klei	zwak zandig, sterk grindig, donker-bruin-grijs, weinig kalkconcreties		
150 - 170	klei	zwak zandig, matig grindig, donker-bruin-grijs		
170 - 180	grind	matig zandig		
180 - 200	klei	zwak zandig, matig grindig, donker-bruin-grijs		
200 - 210	klei	uiterst siltig, donker-bruin-grijs, Opm.: # witte pitjes, met grind		1
210 - 220	klei	uiterst siltig, donker-bruin-grijs, plantenresten		1
220 - 230	klei	matig zandig, donker-grijs, Opm.: iets plr?		1
230 - 240	klei	uiterst siltig, grijs, plantenresten, riet		1
240 - 250	klei	uiterst siltig, grijs, plantenresten, Opm.: #		1
250 - 260	geen monster	Opm.: #		
260 - 270	klei	uiterst siltig, grijs, weinig zwarte vlekken, plantenresten		1
270 - 280	klei	uiterst siltig, zwart-grijs, plantenresten, Opm.: zwart laagje plr		1
280 - 290	klei	uiterst siltig, zwart-grijs, spoor zwarte vlekken, veel plantenresten, Opm.: bovenin brokje Hout		1
290 - 300	klei	sterk siltig, grijs, spoor plantenresten		1
300 - 310	klei	zwak zandig, grijs-zwart, veel plantenresten, Opm.: zwart laagje plr		1
310 - 320	klei	sterk siltig, zwak humeus, bruin-grijs, weinig kalkconcreties, Opm.: #		2
320 - 330	klei	matig zandig, donker-grijs, spoor plantenresten, Opm.: #		1
330 - 340	leem	sterk zandig, donker-grijs		1
340 - 350	klei	uiterst siltig, bruin-grijs, weinig baksteen, Opm.: boven Lz3		1
350 - 360	klei	uiterst siltig, bruin-grijs, weinig plantenresten, weinig kalkconcreties		
360 - 370	klei	sterk siltig, donker-grijs, weinig hout, Opm.: zwarte laagjes plr		1
370 - 380	klei	sterk siltig, donker-grijs, spoor zwarte vlekken		1
380 - 390	klei	sterk siltig, donker-grijs, weinig plantenresten, Opm.: #, zwarte laagjes plr		1
390 - 400	klei	sterk siltig, zwart-grijs, hout, weinig kalkconcreties, weinig veenbrokjes, Opm.: #		
400 - 410	veen	sterk kleiig, donker-grijs-bruin, hout, Opm.: kalkloos		
410 - 420	klei	uiterst siltig, zwak humeus, donker-grijs, weinig baksteen		1

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
420 - 430	klei	matig zandig, donker-grijs, Zand: matig grof, slap, Opm.: erg nat	210-300	1
430 - 440	klei	uiterst siltig, grijs-zwart, baksteen, Opm.: Baksteen 2cm		1
440 - 450	klei	uiterst siltig, matig humeus, donker-bruin-grijs, hout, Opm.: #		1
450 - 460	klei	uiterst siltig, sterk humeus, bruin, Opm.: #		1
460 - 470	veen	sterk kleiig, bruin, Veen: sterk amorf, veel baksteen, Opm.: laagje baksteen onder		1
470 - 480	veen	sterk kleiig, bruin, Veen: sterk amorf, Opm.: #		1
480 - 490	veen	sterk kleiig, bruin, spoor botresten, Opm.: #		1
490 - 500	veen	sterk kleiig, bruin, Schelpen: weinig schelpmateriaal, spoor kalkconcreties		1
500 - 510	klei	uiterst siltig, sterk humeus, bruin-grijs, veel kalkconcreties, Opm.: veel gruis		2
510 - 520	klei	uiterst siltig, sterk humeus, bruin, spoor hout, Schelpen: spoor schelpmateriaal, Opm.: #, mossel		1
520 - 530	geen monster	Opm.: #		
530 - 540	klei	uiterst siltig, zwart-grijs, Opm.: onder gele zandsteen 5cm, kalkloos, Monster M1		
540 - 550	veen	sterk kleiig, grijs-bruin, Veen: sterk amorf, weinig plantenresten		
550 - 560	veen	sterk kleiig, grijs-bruin, Veen: sterk amorf, weinig plantenresten, Opm.: erg compact, Monster M2		
560 - 570	veen	sterk kleiig, grijs-bruin, weinig plantenresten, Opm.: erg compact		
570 - 580	geen monster	Opm.: #		
580 - 590	veen	zwak kleiig, bruin, Opm.: compact		
590 - 600	veen	mineraalarm, bruin, zegge, weinig riet, weinig hout, Opm.: plaatig		
600 - 610	veen	mineraalarm, rood-bruin, veel hout, Opm.: boven riet, onder 2cm hout		
610 - 620	veen	mineraalarm, rood-bruin, hout, wortelresten, Opm.: #		
620 - 630	veen	mineraalarm, bruin, plantenresten, Opm.: #		
630 - 640	veen	mineraalarm, bruin, wortelresten, Opm.: rood hout, Monster M3		
640 - 650	veen	mineraalarm, bruin, riet		
650 - 660	veen	mineraalarm, bruin, bosveen, veel hout		
660 - 670	veen	mineraalarm, bruin, riet, wortelresten, hout		
670 - 680	veen	mineraalarm, bruin, rietveen, riet, zegge, Opm.: #		
680 - 690	veen	mineraalarm, geel-bruin, rietveen, veel riet, Opm.: #, licht plaatig, Monster M4		
690 - 700	veen	mineraalarm, bruin, rietveen, veel riet, Opm.: licht plaatig		
700 - 710	veen	mineraalarm, bruin, weinig riet, veel zegge		
710 - 720	veen	mineraalarm, bruin, zeggeveen, veel zegge, weinig riet, Opm.: Monster M5		
720 - 730	veen	mineraalarm, bruin, zeggeveen, veel zegge, Opm.: # licht plaatig		
730 - 740	veen	mineraalarm, rood-bruin, zeggeveen, veel zegge, weinig riet, hout, Opm.: #, brokkelig		
740 - 750	veen	mineraalarm, rood-bruin, rietveen, weinig zegge, veel riet, Opm.: iets plaatig		
750 - 760	veen	mineraalarm, rood-bruin, zeggeveen, veel zegge		
760 - 770	veen	mineraalarm, bruin, zeggeveen, veel zegge, Opm.: rode plr		
770 - 780	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, veel zegge		
780 - 790	veen	mineraalarm, zwart-bruin, Veen: matig amorf, zeggeveen, veel zegge, spoor riet, spoor hout, Opm.: #		
790 - 800	veen	mineraalarm, zwart-bruin, zeggeveen, veel zegge, Opm.: #		
800 - 810	veen	mineraalarm, bruin, Opm.: ROOD		
810 - 820	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, veel riet		
820 - 830	veen	mineraalarm, donker-bruin, Veen: zwak amorf, rietveen		
830 - 840	veen	mineraalarm, donker-bruin, Veen: zwak amorf, rietveen, Opm.: #		
840 - 850	veen	mineraalarm, rood-bruin, rietveen, spoor hout, Opm.: #, plaatig		
850 - 860	veen	mineraalarm, rood-bruin, rietveen, Opm.: plaatig/brokkelig		
860 - 868	veen	mineraalarm, rood-bruin, rietveen, Opm.: boven bandje 2cm hout		
868 - 870	klei	matig siltig, matig humeus, bruin-grijs, veel plantenresten, Opm.: in het midden bruin bandje 3mm, daar onder: grijs, minder humeus en weinig plantenresten		
870 - 890	veen	mineraalarm, licht-grijs-bruin, Veen: sterk amorf, rietveen, weinig riet		
890 - 900	veen	zwak kleiig, grijs-bruin, Veen: sterk amorf, Opm.: #		
900 - 910	veen	zwak kleiig, grijs-bruin, Veen: matig amorf, hout, riet, wortelresten, Opm.: #		
910 - 920	veen	zwak kleiig, grijs-bruin, Veen: matig amorf, hout		
920 - 930	veen	zwak kleiig, grijs-bruin, Veen: zwak amorf, hout		
930 - 940	veen	mineraalarm, bruin, Veen: sterk amorf, Opm.: # Monster M7		
940 - 950	veen	mineraalarm, bruin, Veen: sterk amorf, spoor hout, Opm.: #		
950 - 960	veen	sterk kleiig, grijs-bruin, Veen: sterk amorf, plantenresten		
960 - 970	veen	sterk kleiig, grijs-bruin, Veen: matig amorf, plantenresten, weinig riet, Opm.: bovenin laagje Vkm (verspoeld)		
970 - 980	veen	sterk kleiig, bruin-grijs, Veen: matig amorf, weinig plantenresten, weinig hout		

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
980 - 990	veen	sterk kleiig, bruin-grijs, Opm.: witte concretie, mogelijk basisveen?, Monster M8		
990 - 1000	klei	sterk siltig, zandig, sterk humeus, donker-grijs, veel plantenresten, Opm.: #, bodem vorming, kalkloos		
1000 - 1010	klei	sterk siltig, zandig, matig humeus, donker-grijs, weinig riet, Opm.: # lichte vlekken, kalkloos		
1010 - 1020	klei	sterk siltig, zandig, zwak humeus, grijs, weinig riet, Opm.: lichte vlekken, kalkloos		
1020 - 1030	klei	sterk siltig, zandig, zwak humeus, grijs, spoor plantenresten, riet, Opm.: lichte vlekken, kalkloos		
1030 - 1040	klei	sterk siltig, zandig, matig humeus, licht-bruin-grijs, weinig zwarte vlekken, weinig plantenresten, Opm.: vergane plr, kalkloos		
1040 - 1050	klei	sterk siltig, zandig, matig humeus, licht-bruin-grijs, weinig zwarte vlekken, Opm.: # vergane plr, kalkloos		
1050 - 1060	klei	matig siltig, zandig, blauw-grijs, Opm.: # kalkloos		
1060 - 1070	klei	sterk siltig, zandig, blauw-grijs, weinig plantenresten, Opm.: kalkloos		
1070 - 1080	klei	sterk siltig, zandig, blauw-grijs, spoor plantenresten, Opm.: iets zandiger kalkloos		
1080 - 1090	klei	uiterst siltig, zandig, blauw-grijs, Opm.: kalkloos		
1090 - 1100	klei	sterk siltig, blauw-grijs, spoor plantenresten, Opm.: # kalkloos		

Universiteit Utrecht

B003

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 108286
Y-coordinaat (m)	: 447458
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: 1
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 1100
Datum boring	: 1-2-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Hartenerf: in een perkje tussen twee grote huizen (10 m uit elkaar). vroeger stonden hier kleine huisjes

Boormethode

Diepte (cm)	Omschrijving
0 - 200	Edelmanboring
200 - 1100	Guts

Lithologie

Grondwater na boren (cm - mv)	: 100
Gem. hoogste grondwaterstand (cm - mv)	: 60

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 20	klei	uiterst siltig, donker-bruin, veel wortelresten, weinig baksteen		
20 - 30	klei	uiterst siltig, donker-bruin, veel wortelresten, weinig baksteen, Opm.: enkel grindje		
30 - 40	klei	uiterst siltig, zwak grindig, donker-bruin, veel wortelresten, weinig baksteen		
40 - 50	klei	uiterst siltig, matig grindig, grijs-bruin, veel wortelresten, spoor kalkconcreties, veel baksteen, Opm.: baksteen 4cm		
50 - 60	klei	uiterst siltig, matig grindig, donker-bruin-grijs, veel kalkconcreties		
60 - 70	klei	zwak zandig, matig grindig, donker-bruin-grijs, spoor baksteen, Opm.: pijpenkopje		
70 - 80	klei	zwak zandig, matig grindig, donker-bruin-grijs, Opm.: kiezels tot 2cm		
80 - 90	klei	zwak zandig, matig grindig, donker-bruin-grijs		
90 - 100	klei	zwak zandig, matig grindig, donker-bruin-grijs		
100 - 110	klei	sterk siltig, donker-grijs, Opm.: dakpan, 4cm		
110 - 120	klei	uiterst siltig, donker-grijs, Opm.: kiezels		
120 - 130	klei	sterk siltig, donker-grijs, spoor hout		
130 - 140	klei	uiterst siltig, matig grindig, donker-bruin-grijs, plantenresten, weinig kalkconcreties, veel baksteen, Opm.: pijpje, steentjes		
140 - 150	klei	uiterst siltig, donker-bruin-grijs, weinig kalkconcreties		
150 - 160	klei	uiterst siltig, donker-bruin-grijs, weinig kalkconcreties		
160 - 170	klei	uiterst siltig, donker-bruin-grijs, veel kalkconcreties		
170 - 180	klei	uiterst siltig, donker-bruin-grijs		
180 - 190	klei	uiterst siltig, donker-bruin-grijs, spoor botresten		
190 - 200	klei	uiterst siltig, grijs-bruin, Opm.: Vk3 bijmenging		
200 - 210	klei	uiterst siltig, grijs-bruin, hout, Opm.: #, boomschors		
210 - 220	klei	uiterst siltig, grijs, spoor kalkconcreties, Opm.: venige bijmenging		
220 - 230	veen	sterk kleiig, bruin, veel kalkconcreties, Opm.: laagje Kz3 cm		
230 - 240	veen	sterk kleiig, bruin, weinig wortelresten, Opm.: Monster M1		
240 - 250	veen	sterk kleiig, bruin, weinig wortelresten		
250 - 260	veen	zwak kleiig, bruin-grijs, veel plantenresten, veel riet, veel wortelresten		
260 - 270	veen	sterk kleiig, bruin-grijs, veel riet		
270 - 280	veen	zwak kleiig, bruin, Veen: matig amorf, veel wortelresten, veel riet, Opm.: #		
280 - 320	veen	zwak kleiig, bruin, veel riet, veel wortelresten, Opm.: #		
320 - 330	klei	uiterst siltig, zwak humeus, grijs, weinig riet		1
330 - 360	klei	uiterst siltig, matig humeus, bruin-grijs, spoor hout, Opm.: #,spoor kiezels		1
360 - 370	klei	sterk siltig, sterk humeus, grijs-bruin, Opm.: #		1
370 - 380	klei	sterk siltig, sterk humeus, grijs-bruin, weinig hout		1

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
380 - 390	klei	sterk siltig, matig humeus, bruin-grijs, weinig hout, Schelpen: spoor schelpmateriaal		1
390 - 400	klei	sterk siltig, sterk humeus, grijs-bruin, weinig hout		1
400 - 410	klei	sterk siltig, sterk humeus, grijs-bruin, weinig hout, spoor kalkconcreties		1
410 - 420	klei	sterk siltig, sterk humeus, grijs-bruin, weinig hout		1
420 - 430	klei	uiterst siltig, sterk humeus, grijs-bruin, weinig grijze vlekken, Opm.: #		1
430 - 440	klei	sterk siltig, matig humeus, bruin-grijs, spoor kalkconcreties, Opm.: #		1
440 - 450	klei	sterk siltig, zwak humeus, bruin-grijs, weinig hout, spoor kalkconcreties		1
450 - 460	klei	sterk siltig, zwak humeus, bruin-grijs, weinig hout, spoor kalkconcreties		1
460 - 470	klei	uiterst siltig, zwak humeus, grijs-bruin, spoor plantenresten, spoor kalkconcreties, spoor baksteen		1
470 - 480	klei	uiterst siltig, matig humeus, grijs-bruin, spoor hout, Opm.: bijmenging grijze klei		1
480 - 490	veen	zwak kleiig, bruin, Veen: matig amorf, weinig hout		1
490 - 500	veen	zwak kleiig, bruin, Veen: sterk amorf, weinig hout, Opm.: #, Monster M2		1
500 - 510	veen	zwak kleiig, grijs-bruin, Veen: matig amorf, Opm.: # gelaagd, redelijk nat, zaadjes		
510 - 520	veen	sterk kleiig, bruin-grijs, veel riet, spoor baksteen, Opm.: zaadjes		
520 - 530	veen	zwak kleiig, bruin, Veen: zwak amorf, weinig hout, weinig riet		
530 - 540	veen	zwak kleiig, bruin, Veen: zwak amorf, weinig hout, weinig riet, Opm.: Monster M3		
540 - 550	veen	mineraalarm, rood-bruin, Veen: zwak amorf, veel hout, weinig riet, Opm.: hout 2cm		
550 - 560	veen	mineraalarm, rood-bruin, Veen: zwak amorf, weinig riet, Opm.: # brokkelig		
560 - 570	veen	mineraalarm, rood-bruin, Veen: zwak amorf, veel hout, Opm.: #		
570 - 580	veen	mineraalarm, rood-bruin, Veen: zwak amorf, weinig hout		
580 - 590	veen	mineraalarm, rood-bruin, Veen: zwak amorf, riet, weinig wortelresten, Opm.: #		
590 - 600	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, veel hout, Opm.: #		
600 - 610	veen	mineraalarm, rood-bruin, Veen: matig amorf, weinig riet, weinig zegge		
610 - 620	veen	mineraalarm, rood-bruin, Veen: matig amorf, weinig plantenresten		
620 - 630	veen	mineraalarm, rood-bruin, Veen: matig amorf, weinig plantenresten, Opm.: #		
630 - 640	veen	zwak kleiig, rood-bruin, Opm.: #		
640 - 650	veen	mineraalarm, bruin, Veen: zwak amorf, weinig riet, Opm.: Monster M4		
650 - 660	veen	mineraalarm, bruin, Veen: zwak amorf, weinig riet, veel zegge		
660 - 670	veen	mineraalarm, bruin, Veen: matig amorf, weinig riet, veel zegge		
670 - 680	veen	mineraalarm, bruin, Veen: matig amorf, weinig riet, veel zegge, Opm.: #		
680 - 690	veen	mineraalarm, bruin, zeggeveen, Opm.: #		
690 - 700	veen	mineraalarm, bruin, zeggeveen		
700 - 710	veen	mineraalarm, bruin, zeggeveen, weinig riet		
710 - 720	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, weinig riet		
720 - 730	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, weinig riet, spoor hout, Opm.: #		
730 - 740	veen	mineraalarm, donker-bruin, zeggeveen, weinig riet, Opm.: #		
740 - 750	veen	zwak kleiig, zwart-bruin, Veen: sterk amorf, zeggeveen, weinig riet		
750 - 760	veen	zwak kleiig, zwart-bruin, Veen: sterk amorf, zeggeveen, weinig riet		
760 - 770	veen	zwak kleiig, zwart-bruin, Veen: sterk amorf, weinig riet, Opm.: #		
770 - 780	veen	zwak kleiig, zwart-bruin, Veen: sterk amorf, Opm.: #		
780 - 790	veen	zwak kleiig, zwart-bruin, Veen: zwak amorf, zeggeveen, weinig riet		
790 - 800	veen	zwak kleiig, zwart-bruin, Veen: zwak amorf, zeggeveen, weinig hout, weinig riet		
800 - 810	veen	zwak kleiig, zwart-bruin, Veen: matig amorf, hout, weinig riet		
810 - 820	veen	zwak kleiig, zwart-bruin, Veen: zwak amorf, zeggeveen		
820 - 830	veen	zwak kleiig, zwart-bruin, Veen: zwak amorf, zeggeveen		
830 - 840	geen monster	Opm.: #		
840 - 850	veen	zwak kleiig, donker-bruin, Veen: sterk amorf, Opm.: #, onderin 2cm hout, Monster M5		
850 - 860	veen	zwak kleiig, rood-bruin, Veen: matig amorf, weinig hout, weinig riet		
860 - 870	veen	zwak kleiig, rood-bruin, Veen: matig amorf, veel riet		
870 - 880	veen	zwak kleiig, rood-bruin, Veen: matig amorf		
880 - 890	veen	zwak kleiig, donker-bruin, Veen: sterk amorf, spoor hout, veel zegge, veel riet, Opm.: #		
890 - 900	veen	zwak kleiig, bruin, veel hout, Opm.: 3		
900 - 907	veen	sterk kleiig, bruin		
907 - 913	klei	sterk siltig, zwak humeus, bruin-grijs, Opm.: bovenin humeuzer, bandje h3 bovenin 5mm, bandje veen onder 7mm, foto beschikbaar		
913 - 916	veen	sterk kleiig, bruin		
916 - 918	klei	sterk siltig, grijs, Opm.: dunne humeuze bandjes		
918 - 930	veen	mineraalarm, rood-bruin, Veen: matig amorf, hout		
930 - 940	veen	zwak kleiig, rood-bruin, Veen: matig amorf, weinig zegge, Opm.: #		

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
940 - 950	veen	zwak kleiig, bruin, Veen: matig amorf, spoor hout, Opm.: #		
950 - 960	veen	zwak kleiig, bruin-grijs, weinig riet, Opm.: Monster M6		
960 - 970	veen	zwak kleiig, bruin-grijs, weinig riet, spoor hout, Opm.: #		
970 - 980	veen	sterk kleiig, bruin-grijs, veel plantenresten, weinig riet, Opm.: #		
980 - 990	veen	sterk kleiig, bruin-grijs, veel plantenresten, spoor hout, Opm.: CA-0		
990 - 1000	klei	matig siltig, matig humeus, grijs, veel plantenresten, Opm.: Ca-0		
1000 - 1010	klei	sterk siltig, sterk humeus, grijs, plantenresten, weinig riet, spoor hout, Opm.: Ca-0		
1010 - 1020	klei	sterk siltig, sterk humeus, grijs, spoor hout, Opm.: #, Ca-0		
1020 - 1030	klei	uiterst siltig, blauw-grijs, Opm.: # Ca-0		
1030 - 1040	klei	uiterst siltig, blauw-grijs, Opm.: Ca-0		
1040 - 1050	klei	uiterst siltig, blauw-grijs, spoor zwarte vlekken, Opm.: Ca-0		
1050 - 1060	klei	uiterst siltig, blauw-grijs, spoor zwarte vlekken, Opm.: Ca-0		
1060 - 1070	klei	sterk zandig, blauw-grijs, spoor hout, Opm.: Ca-0		
1070 - 1080	klei	uiterst siltig, blauw-grijs, Opm.: Ca-0		
1080 - 1090	klei	uiterst siltig, blauw-grijs		1
1090 - 1100	klei	uiterst siltig, blauw-grijs, Opm.: #		1

Universiteit Utrecht

B004

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 108073
Y-coordinaat (m)	: 447084
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: -3
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 720
Datum boring	: 2-2-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Pleintje aan Verlorenkost onder kinderkop, verwachte diepte veen 4.5 m. Terugstromen zand geeft soms verstoring.

Boormethode

Diepte (cm)	Omschrijving
0 - 140	Edelmanboring
140 - 310	Van der Staay boring
310 - 720	Guts

Lithologie

Grondwater na boren (cm - mv)	: 100
Gem. hoogste grondwaterstand (cm - mv)	: 70
Gem. laagste grondwaterstand (cm - mv)	: 140

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 20	stenen	Opm.: kinderkop		
20 - 50	zand	zwak siltig, geel, Zand: matig grof, Schelpen: spoor schelpmateriaal, Opm.: matig gesorteerd	210-300	1
50 - 60	zand	zwak siltig, geel, Zand: matig grof, Schelpen: spoor schelpmateriaal, Opm.: matig gesorteerd, enkele kiezels	210-300	1
60 - 70	zand	zwak siltig, geel, Zand: matig grof, Schelpen: spoor schelpmateriaal, veel baksteen, Opm.: matig gesorteerd, enkele kiezels	210-300	1
70 - 80	zand	zwak siltig, grijs-geel, Zand: matig grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd, kiezels	210-300	1
80 - 90	zand	zwak siltig, geel-grijs, Zand: matig grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd, kiezels	210-300	1
90 - 110	zand	zwak siltig, grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd, kiezels	300	1
110 - 130	zand	zwak siltig, zwak grindig, grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd	300	1
130 - 140	zand	zwak siltig, zwak grindig, grijs, veel zwarte vlekken, Zand: zeer grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd, Monster M1	300	1
140 - 150	zand	zwak siltig, zwak grindig, grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal, Opm.: $ matig gesorteerd	300	1
150 - 160	zand	zwak siltig, zwak grindig, grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd	300	1
160 - 170	zand	zwak siltig, zwak grindig, grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd, hele schelp	300	1
170 - 180	zand	zwak siltig, zwak grindig, grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd, laagje Ks3 2,5cm	300	1
180 - 190	zand	zwak siltig, zwak grindig, grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd	300	1
190 - 200	zand	zwak siltig, zwak grindig, grijs, Zand: matig grof, Schelpen: weinig schelpmateriaal, Opm.: $matig gesorteerd	210-300	1
200 - 210	zand	zwak siltig, zwak grindig, grijs, Zand: matig grof, Schelpen: weinig schelpmateriaal, Opm.: $matig gesorteerd	210-300	1
210 - 240	zand	zwak siltig, zwak grindig, grijs, Zand: matig grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd	210-300	1

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B004

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
240 - 250	zand	zwak siltig, zwak grindig, grijs, Zand: matig grof, Schelpen: weinig schelpmateriaal, Opm.: matig gesorteerd, klei brokje	210-300	1
250 - 310	zand	zwak siltig, zwak grindig, grijs, Zand: matig grof, Schelpen: weinig schelpmateriaal, Opm.: $matig gesorteerd	210-300	1
310 - 320	zand	zwak siltig, grijs, Zand: matig grof, Schelpen: weinig schelpmateriaal, weinig baksteen, Opm.: #	210-300	1
320 - 330	zand	zwak siltig, grijs		1
330 - 340	klei	uiterst siltig, zwak humeus, bruin-grijs, weinig zwarte vlekken, Opm.: #		2
340 - 350	klei	uiterst siltig, zwak humeus, bruin-grijs, spoor zwarte vlekken, weinig baksteen, Opm.: #		2
350 - 360	zand	sterk siltig, bruin-grijs, weinig baksteen		2
360 - 370	zand	uiterst siltig, grijs, veel zwarte vlekken, Opm.: boven veel baksteen 5cm		2
370 - 380	zand	uiterst siltig, donker-grijs, veel zwarte vlekken, Opm.: bandje Vk3 0.8cm		2
380 - 390	zand	uiterst siltig, bruin-grijs, veel zwarte vlekken		2
390 - 400	zand	uiterst siltig, bruin-grijs, veel zwarte vlekken, Opm.: # onder 3cm Vk1		2
400 - 410	geen monster	Opm.: #		
410 - 420	klei	sterk siltig, sterk humeus, grijs-bruin, spoor hout		2
420 - 430	veen	sterk kleiig, bruin, Veen: matig amorf, spoor hout, weinig kalkconcreties, weinig baksteen		
430 - 440	veen	sterk kleiig, bruin, Veen: sterk amorf, weinig kalkconcreties, Opm.: #		
440 - 450	geen monster	Opm.: #		
450 - 460	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, Opm.: plaatig, Ca-0		
460 - 470	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, Opm.: # Ca-0		
470 - 480	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, Opm.: #		
480 - 490	veen	sterk kleiig, bruin, Veen: sterk amorf		
490 - 500	veen	sterk kleiig, bruin, Veen: sterk amorf, Opm.: #		
500 - 510	klei	sterk siltig, sterk humeus, donker-grijs, spoor hout, Opm.: #		2
510 - 530	klei	sterk siltig, sterk humeus, donker-grijs, spoor hout		2
530 - 540	klei	sterk siltig, sterk humeus, donker-grijs, spoor hout, Opm.: #		1
540 - 550	klei	matig siltig, sterk humeus, grijs, weinig hout, weinig riet, houtskool, Opm.: #		1
550 - 560	veen	sterk kleiig, bruin-grijs, Opm.: Ca-0, Monster M4		
560 - 570	veen	sterk kleiig, bruin-grijs, Schelpen: spoor schelpmateriaal		
570 - 580	veen	sterk kleiig, grijs-bruin, Opm.: monster M5		
580 - 590	veen	sterk kleiig, grijs-bruin, weinig houtskool, spoor baksteen		
590 - 600	veen	sterk kleiig, grijs-bruin, weinig wortelresten, weinig houtskool, Opm.: #		
600 - 610	geen monster	Opm.: #		
610 - 620	veen	zwak kleiig, bruin, Veen: matig amorf, hout		
620 - 630	veen	mineraalarm, bruin, Veen: matig amorf, hout		
630 - 640	hout	rood-bruin		
640 - 650	veen	mineraalarm, rood-bruin, Veen: sterk amorf, weinig wortelresten, Opm.: #		
650 - 660	veen	mineraalarm, rood-bruin, Veen: matig amorf, bosveen, spoor hout		
660 - 670	veen	mineraalarm, rood-bruin, Veen: matig amorf, bosveen, spoor riet, spoor hout, Opm.: Monster M6		
670 - 680	veen	mineraalarm, rood-bruin, Veen: matig amorf, spoor riet		
680 - 690	veen	mineraalarm, rood-bruin, Veen: matig amorf, spoor hout, spoor zegge, Opm.: 3		
690 - 700	veen	mineraalarm, rood-bruin, spoor hout, Opm.: #		
700 - 710	veen	mineraalarm, rood-bruin, spoor hout, weinig zegge		
710 - 720	veen	mineraalarm, rood-bruin, weinig zegge, weinig riet, Opm.: #		

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B005A

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 107760
Y-coordinaat (m)	: 446850
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: -164
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 250
Datum boring	: 7-2-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Parkeersplaat tussen nieuwbouw aan Westerkade en Snoystraat. Boring na 2.50 m gestaakt, hard voorwerp (fundering?).

Boormethode

Diepte (cm)	Omschrijving
0 - 140	Edelmanboring
140 - 250	Van der Staay boring

Lithologie

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 20	zand	uiterst siltig, sterk humeus, donker-grijs-bruin, veel wortelresten, Opm.: Ca-0		
20 - 30	zand	uiterst siltig, matig grindig, sterk humeus, donker-grijs-bruin, veel wortelresten		
30 - 40	zand	uiterst siltig, sterk grindig, donker-grijs, veel wortelresten, Opm.: veel gruis		
40 - 50	klei	uiterst siltig, sterk grindig, donker-grijs, weinig wortelresten, Opm.: veel gruis		
50 - 60	klei	uiterst siltig, sterk grindig, donker-grijs, Opm.: veel gruis		
60 - 80	klei	uiterst siltig, sterk grindig, donker-grijs, Opm.: veel gruis		
80 - 90	klei	uiterst siltig, sterk grindig, donker-bruin-grijs, Opm.: veel gruis, Monster M1		
90 - 100	klei	uiterst siltig, sterk grindig, donker-bruin-grijs, Opm.: veel gruis		
100 - 140	zand	zwak siltig, grijs, Zand: matig grof, Schelpen: veel schelpmateriaal, Opm.: matig gesorteerd	210-300	1
140 - 150	zand	zwak siltig, grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal, Opm.: $	300-420	1
150 - 160	zand	zwak siltig, grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal	300-420	1
160 - 180	zand	zwak siltig, blauw-grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal	300	1
180 - 190	zand	zwak siltig, blauw-grijs, Zand: zeer grof, Schelpen: weinig schelpmateriaal	300-420	1
190 - 200	zand	zwak siltig, blauw-grijs, Zand: uiterst grof, Schelpen: weinig schelpmateriaal, Opm.: $	420	1
200 - 210	zand	zwak siltig, blauw-grijs, Zand: uiterst grof, Opm.: $	420	1
210 - 240	zand	zwak siltig, blauw-grijs, Zand: zeer grof	300-420	1
240 - 250	zand	zwak siltig, blauw-grijs, Zand: matig grof, Opm.: $	210-300	1

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B005B

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 107727
Y-coordinaat (m)	: 446884
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: -165
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 940
Datum boring	: 7-2-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Tegenover Westerkade 85 in het gras dicht bij het water.

Boormethode

Diepte (cm)	Omschrijving
0 - 130	Edelmanboring
130 - 940	Guts

Lithologie

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 20	klei	uiterst siltig, zandig, donker-bruin, weinig wortelresten		
20 - 30	klei	uiterst siltig, zandig, zwart-bruin, weinig wortelresten		
30 - 40	klei	uiterst siltig, zandig, zwart-bruin, spoor wortelresten, Opm.: grijze klei brokjes, glas scherf		
40 - 50	veen	sterk kleiig, donker-bruin, spoor wortelresten, Opm.: bovenkant Ks4 met grijze klei		
50 - 60	veen	sterk kleiig, donker-bruin		
60 - 70	veen	sterk kleiig, donker-bruin		
70 - 80	klei	sterk siltig, sterk humeus, zwart-bruin, kleibrokjes		
80 - 90	klei	sterk siltig, sterk humeus, zwart-bruin, kleibrokjes		
90 - 100	klei	sterk siltig, sterk humeus, zwart-bruin, plantenresten, Opm.: zwarte plr		
100 - 110	veen	sterk kleiig, zwart-bruin		
110 - 120	veen	sterk kleiig, zwart-bruin, weinig zwarte vlekken		
120 - 130	veen	mineraalarm, donker-bruin, Veen: matig amorf, weinig plantenresten		
130 - 140	veen	mineraalarm, donker-bruin, Veen: matig amorf, Opm.: #		
140 - 150	klei	matig zandig, donker-bruin-grijs, Opm.: boven Vkm		
150 - 160	klei	sterk siltig, sterk humeus, donker-bruin-grijs, weinig grijze vlekken, weinig hout		
160 - 170	veen	mineraalarm, bruin, Veen: matig amorf, weinig hout, Opm.: boven Ks3		
170 - 180	veen	mineraalarm, zwart-bruin, Veen: sterk amorf		
180 - 190	zand	uiterst siltig, zwart, Opm.: bijmenging Ks3		
190 - 200	klei	sterk siltig, licht-bruin-grijs, Schelpen: weinig schelpmateriaal, weinig kalkconcreties, Opm.: #, bovenin zwart hout		
200 - 210	geen monster	Opm.: #		
210 - 220	veen	zwak kleiig, grijs-bruin, Veen: sterk amorf, baksteen, Opm.: kiezels, onderin: puin		
220 - 230	veen	zwak kleiig, bruin, baksteen, Opm.: kiezels, bovenin: puin		
230 - 240	veen	zwak kleiig, bruin, weinig hout		
240 - 250	veen	sterk kleiig, grijs-bruin, plantenresten		
250 - 260	veen	zwak kleiig, rood-bruin, Veen: sterk amorf, plantenresten, Opm.: #		
260 - 270	veen	mineraalarm, rood-bruin, Opm.: #, 10cm overschoten		
270 - 350	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, zegge, spoor riet, hout, Opm.: #, Monster M1 op z=310cm		
350 - 360	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, hout, Opm.: #, 10 cm overschoten		
360 - 370	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, hout, Opm.: onderin 3cm hout		
370 - 390	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, hout, spoor riet		
390 - 400	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, hout, Opm.: stuk hout 2cm		
400 - 440	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, hout, Opm.: #		
440 - 450	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, hout, Opm.: #		
450 - 460	veen	mineraalarm, bruin, Veen: zwak amorf, zegge		
460 - 470	veen	mineraalarm, bruin, hout, weinig riet		
470 - 490	veen	mineraalarm, bruin, zeggeveen, spoor riet, Opm.: Monster M2 op z=490		
490 - 500	veen	mineraalarm, bruin, zeggeveen, spoor riet, spoor hout		

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
500 - 520	veen	mineraalarm, donker-bruin, zeggeveen, weinig riet, Opm.: #		
520 - 530	veen	mineraalarm, donker-bruin, zeggeveen, weinig riet, Opm.: #		
530 - 540	veen	mineraalarm, donker-bruin, zeggeveen, weinig riet, hout		
540 - 600	veen	mineraalarm, zwart-bruin, rietveen, Opm.: #, Monster 3 op z=560		
600 - 610	veen	mineraalarm, zwart-bruin, rietveen, Opm.: #		
610 - 640	veen	mineraalarm, zwart-bruin, rietveen		
640 - 650	klei	matig siltig, zwak humeus, grijs, veel riet, Opm.: Monster M4		
650 - 660	veen	mineraalarm, rood-bruin, Veen: matig amorf, Opm.: #		
660 - 670	veen	mineraalarm, rood-bruin, Veen: matig amorf, Opm.: #		
670 - 680	veen	mineraalarm, rood-bruin, Veen: matig amorf, hout		
680 - 690	veen	mineraalarm, rood-bruin, Veen: matig amorf, hout, spoor riet		
690 - 700	veen	mineraalarm, rood-bruin, spoor riet		
700 - 710	veen	mineraalarm, bruin, weinig riet		
710 - 720	veen	zwak kleiig, grijs-bruin		
720 - 730	veen	zwak kleiig, bruin, veel hout		
730 - 740	hout	geel, Opm.: #		
740 - 750	hout	rood-geel, Opm.: #		
750 - 780	veen	mineraalarm, bruin, veel hout, Opm.: erg veel hout		
780 - 800	veen	zwak kleiig, donker-grijs-bruin, weinig hout, weinig riet		
800 - 810	geen monster	Opm.: #		
810 - 820	veen	mineraalarm, bruin, hout, Opm.: #		
820 - 850	hout	rood-geel, Opm.: Monster M5 op z=850		
850 - 860	veen	sterk kleiig, bruin-grijs, Opm.: #		
860 - 870	geen monster	Opm.: #		
870 - 880	veen	zwak kleiig, bruin-grijs, veel riet, weinig hout		
880 - 890	veen	zwak kleiig, bruin-grijs, weinig riet, weinig hout		
890 - 900	klei	sterk siltig, zwak humeus, donker-grijs, veel riet		
900 - 910	klei	sterk siltig, donker-blauw-grijs, veel plantenresten, Opm.: bodem vorming		
910 - 920	klei	sterk siltig, donker-blauw-grijs, weinig plantenresten, Opm.: bodem vorming		
920 - 930	klei	sterk siltig, blauw-grijs, spoor plantenresten		
930 - 940	klei	sterk siltig, blauw-grijs, Opm.: #		

Universiteit Utrecht

B006

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 107625
Y-coordinaat (m)	: 446736
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: -198
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 1040
Datum boring	: 7-2-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Emmastraat in het gras aan het water. Schuin geboord met ongeveer 10 graden.

Boormethode

Diepte (cm)	Omschrijving
0 - 100	Edelmanboring
100 - 1040	Guts

Lithologie

Diepte (cm)	Grondsoort	Omschrijving	Ca M63	
0 - 40	klei	uiterst siltig, zandig, donker-bruin, veel wortelresten		
40 - 70	klei	uiterst siltig, donker-bruin, veel bruine vlekken, veel wortelresten		
70 - 80	klei	uiterst siltig, donker-grijs, veel grijze vlekken, veel wortelresten		
80 - 90	klei	uiterst siltig, donker-grijs, weinig bruine vlekken, veel grijze vlekken		
90 - 100	klei	uiterst siltig, donker-grijs, veel grijze vlekken		
100 - 110	geen monster	Opm.: #		
110 - 120	klei	uiterst siltig, donker-grijs		
120 - 130	klei	uiterst siltig, sterk humeus, donker-bruin, Opm.: kleiig laagje		
130 - 140	veen	sterk kleiig, donker-bruin, Opm.: kleiig laagje		
140 - 150	veen	sterk kleiig, donker-bruin		
150 - 160	klei	uiterst siltig, matig humeus, bruin-grijs, Opm.: #		
160 - 170	klei	uiterst siltig, zwak humeus, licht-bruin-grijs, Opm.: #		
170 - 180	klei	uiterst siltig, zwak humeus, licht-bruin-grijs		
180 - 190	veen	zwak kleiig, donker-bruin, Veen: zwak amorf, weinig hout		
190 - 200	veen	zwak kleiig, donker-bruin, Veen: zwak amorf, weinig hout, Opm.: kiezel		
200 - 210	veen	zwak kleiig, bruin, Veen: zwak amorf, weinig hout, Opm.: Monster M1		
210 - 220	veen	zwak kleiig, bruin, Veen: zwak amorf, veel plantenresten, Opm.: #		
220 - 230	veen	zwak kleiig, donker-bruin, weinig veenbrokjes, Opm.: # erg nat		
230 - 240	veen	zwak kleiig, donker-bruin, spoor kalkconcreties, weinig kleibrokjes, weinig veenbrokjes, Opm.: erg nat		
240 - 250	veen	zwak kleiig, donker-bruin, weinig veenbrokjes, Opm.: erg nat		
250 - 270	veen	zwak kleiig, donker-bruin, Opm.: erg nat		
270 - 280	veen	zwak kleiig, donker-bruin, weinig hout		
280 - 290	veen	zwak kleiig, donker-bruin		
290 - 300	veen	zwak kleiig, donker-bruin, Opm.: #		
300 - 310	geen monster	Opm.: #		
310 - 330	veen	mineraalarm, rood-bruin, bosveen		
330 - 360	veen	mineraalarm, rood-bruin, bosveen, weinig riet, Opm.: #		
360 - 370	veen	mineraalarm, rood-bruin, Veen: matig amorf, Opm.: #, erg nat		
370 - 380	veen	mineraalarm, rood-bruin, Veen: matig amorf, Opm.: 4cm hout		
380 - 390	veen	mineraalarm, rood-bruin, weinig zegge, weinig riet, Opm.: erg nat		
390 - 430	veen	mineraalarm, rood-bruin, veel hout, Opm.: erg nat, laatste 10cm wat harder		
430 - 440	veen	mineraalarm, rood-bruin, Opm.: #		
440 - 450	veen	mineraalarm, rood-bruin, weinig hout, Opm.: #		
450 - 460	veen	mineraalarm, rood-bruin, zegge, weinig riet, weinig hout		
460 - 490	veen	mineraalarm, rood-bruin, zeggeveen, Opm.: Monster M2 op z=490		
490 - 500	veen	mineraalarm, rood-bruin, zeggeveen, weinig riet, weinig hout		
500 - 520	veen	mineraalarm, donker-bruin, zeggeveen, hout, Opm.: #		
520 - 530	veen	mineraalarm, donker-bruin, zeggeveen, spoor riet, Opm.: #		
530 - 540	veen	mineraalarm, donker-bruin, zeggeveen, spoor riet, spoor hout		
540 - 550	veen	mineraalarm, zwart-bruin, zeggeveen, weinig riet		

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
550 - 580	veen	mineraalarm, zwart-bruin, zeggeveen, veel riet		
580 - 600	veen	mineraalarm, zwart-bruin, rietveen, veel riet, Opm.: #		
600 - 610	veen	mineraalarm, donker-bruin, rietveen, Opm.: #		
610 - 670	veen	mineraalarm, donker-bruin, rietveen, Opm.: #		
670 - 680	klei	zwak siltig, grijs, veel riet, Opm.: #, compleet vol met erg veel riet, Monster M3		
680 - 690	klei	zwak siltig, sterk humeus, bruin-grijs, veel riet		
690 - 700	klei	zwak siltig, blauw-grijs, Opm.: schone klei		
700 - 720	veen	mineraalarm, rood-bruin, Opm.: #, nat		
720 - 730	veen	mineraalarm, bruin, Veen: matig amorf, weinig hout, Opm.: #		
730 - 740	veen	mineraalarm, bruin, Veen: matig amorf, Opm.: donker grijs kleiig bandje		
740 - 750	veen	mineraalarm, bruin, Veen: matig amorf, hout, Opm.: onder 2cm hout		
750 - 760	hout	rood-geel		
760 - 770	veen	mineraalarm, bruin, Veen: matig amorf		
770 - 780	veen	mineraalarm, bruin, Veen: matig amorf, veel riet		
780 - 790	veen	zwak kleiig, bruin, weinig riet		
790 - 800	veen	zwak kleiig, bruin, Opm.: #		
800 - 810	veen	sterk kleiig, donker-grijs-bruin, Opm.: #		
810 - 820	veen	sterk kleiig, bruin		
820 - 830	veen	mineraalarm, bruin, rietveen, Opm.: boven kleiig		
830 - 840	veen	mineraalarm, bruin, rietveen		
840 - 850	veen	mineraalarm, bruin, rietveen, spoor hout		
850 - 860	veen	sterk kleiig, bruin-grijs		
860 - 880	klei	sterk siltig, matig humeus, bruin-grijs, weinig riet, Opm.: #		
880 - 890	veen	sterk kleiig, bruin-grijs, Opm.: #		
890 - 900	veen	zwak kleiig, bruin, weinig riet		
900 - 910	veen	sterk kleiig, donker-bruin-grijs, weinig riet, Opm.: bandje riet		
910 - 920	klei	sterk siltig, matig humeus, donker-grijs, weinig plantenresten		
920 - 930	klei	sterk siltig, matig humeus, donker-grijs, Opm.: Ca-0, boven veel riet		
930 - 940	klei	sterk siltig, grijs, Opm.: Ca-0, bandjes riet		
940 - 950	klei	sterk siltig, donker-blauw-grijs, weinig zwarte vlekken, weinig riet, Opm.: Ca-0, bodem vorming		
950 - 960	klei	sterk siltig, blauw-grijs, plantenresten, Opm.: # Ca-0, bodem vorming		
960 - 970	klei	sterk siltig, blauw-grijs, spoor riet, Opm.: # Ca-0		
970 - 990	klei	sterk siltig, blauw-grijs, spoor riet, Opm.: Ca-0		
990 - 1040	klei	sterk siltig, blauw-grijs, Opm.: # Ca-0		

Universiteit Utrecht

B007

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 108096
Y-coordinaat (m)	: 446863
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: -142
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 890
Datum boring	: 3-2-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Parkeersplaat op Erasmuslein, vroeger bebouwd. Laatste steek niet af te draaien, waarschijnlijk grove zandlaag.

Boormethode

Diepte (cm)	Omschrijving
0 - 140	Edelmanboring
140 - 860	Guts

Lithologie

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 20	zand	sterk siltig, sterk humeus, zwart-bruin, veel wortelresten		1
20 - 30	zand	uiterst siltig, matig humeus, donker-grijs-bruin, weinig wortelresten		1
30 - 50	zand	zwak siltig, geel, Zand: matig grof, Schelpen: spoor schelpmateriaal, Opm.: boomwortel	210-300	1
50 - 70	zand	zwak siltig, grijs, Zand: matig grof	210	1
70 - 80	klei	uiterst siltig, sterk humeus, zwart-grijs, veel wortelresten, weinig baksteen		1
80 - 90	klei	matig zandig, sterk humeus, zwart-bruin, veel wortelresten		1
90 - 100	klei	sterk siltig, sterk humeus, zwart-bruin, veel wortelresten		1
100 - 110	klei	uiterst siltig, sterk humeus, zwart-grijs		
110 - 120	klei	uiterst siltig, sterk humeus, zwart-bruin, spoor kalkconcreties, weinig houtskool		
120 - 130	klei	uiterst siltig, sterk humeus, zwart-bruin, weinig houtskool		
130 - 140	veen	sterk kleiig, zwart-bruin, Veen: sterk amorf, Opm.: Monster M1		
140 - 150	veen	mineraalarm, bruin, Veen: zwak amorf, riet, zegge, Opm.: #, nat		
150 - 160	veen	zwak kleiig, bruin, Veen: sterk amorf, spoor hout, Opm.: erg nat		
160 - 170	veen	zwak kleiig, bruin, Veen: sterk amorf, Opm.: plakje zegge		
170 - 180	veen	mineraalarm, licht-bruin, Veen: sterk amorf, veel zegge		
180 - 190	veen	mineraalarm, donker-bruin, Veen: matig amorf		
190 - 200	klei	sterk siltig, matig humeus, bruin-grijs, weinig houtskool		2
200 - 210	klei	sterk siltig, matig humeus, bruin-grijs, weinig houtskool		1
210 - 220	klei	sterk siltig, matig humeus, bruin-grijs, weinig houtskool, Opm.: #, mosselfrag		1
220 - 230	klei	sterk siltig, matig humeus, bruin-grijs, Opm.: #		1
230 - 240	klei	sterk siltig, matig humeus, bruin-grijs, weinig plantenresten, Schelpen: spoor schelpmateriaal, weinig kalkconcreties, weinig houtskool, weinig baksteen		1
240 - 250	veen	sterk kleiig, bruin-grijs, Veen: sterk amorf, Schelpen: spoor schelpmateriaal, weinig kalkconcreties, spoor houtskool		
250 - 260	klei	matig siltig, sterk humeus, bruin-grijs, Schelpen: spoor schelpmateriaal, weinig kalkconcreties, veel veenbrokjes, spoor baksteen, Opm.: mossel		
260 - 270	veen	sterk kleiig, bruin-grijs, Veen: matig amorf, Schelpen: spoor schelpmateriaal, weinig kleibrokjes, spoor baksteen		1
270 - 280	veen	zwak kleiig, bruin, Veen: sterk amorf, Opm.: Ca-0		
280 - 290	veen	zwak kleiig, bruin, Veen: matig amorf, spoor hout		
290 - 300	veen	zwak kleiig, bruin, Veen: matig amorf, weinig plantenresten, Opm.: #		
300 - 310	veen	zwak kleiig, grijs-bruin, Veen: matig amorf, weinig riet, weinig hout, Opm.: #		
310 - 320	veen	mineraalarm, geel-bruin, Veen: matig amorf, weinig hout, Opm.: gelaagd, laagje riet, Monster M2		
320 - 330	veen	mineraalarm, geel-bruin, Veen: matig amorf, weinig zegge, Opm.: laagje 2 cm plr		
330 - 340	veen	mineraalarm, rood-bruin, Veen: matig amorf, weinig zegge, weinig hout, Opm.: Monster M3		
340 - 350	veen	mineraalarm, rood-bruin, Veen: matig amorf, weinig zegge		
350 - 360	veen	mineraalarm, rood-bruin, Veen: matig amorf, veel zegge, spoor hout, weinig riet		

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B007

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
360 - 370	veen	mineraalarm, rood-bruin, Veen: zwak amorf, veel zegge, Opm.: #		
370 - 380	veen	mineraalarm, rood-bruin, Veen: matig amorf, zegge, hout, Opm.: #, nat		
380 - 390	veen	mineraalarm, rood-bruin, Veen: matig amorf, veel zegge, spoor riet, Opm.: nat		
390 - 400	veen	mineraalarm, rood-bruin, Veen: matig amorf, veel hout, weinig riet, Opm.: nat		
400 - 410	veen	mineraalarm, rood-bruin, Veen: matig amorf, veel hout, Opm.: nat		
410 - 420	veen	mineraalarm, donker-bruin, Veen: matig amorf, bosveen, veel hout, Opm.: nat		
420 - 430	veen	mineraalarm, donker-bruin, Veen: matig amorf, weinig hout, veel zegge, Opm.: nat		
430 - 440	veen	mineraalarm, donker-bruin, Veen: matig amorf, weinig hout, weinig zegge, Opm.: nat		
440 - 450	veen	mineraalarm, donker-bruin, Veen: matig amorf, weinig hout, veel zegge, Opm.: nat,#		
450 - 460	veen	mineraalarm, rood-bruin, Veen: zwak amorf, weinig hout, weinig riet, Opm.: #, nat, Monster M4		
460 - 470	veen	mineraalarm, donker-rood-bruin, Veen: zwak amorf, weinig hout, veel zegge, Opm.: #, nat		
470 - 480	veen	mineraalarm, rood-bruin, Veen: zwak amorf, weinig hout, Opm.: #		
480 - 490	veen	mineraalarm, rood-bruin, weinig hout, spoor riet		
490 - 500	veen	mineraalarm, rood-bruin, zeggeveen, Opm.: horizontale laagjes riet		
500 - 510	veen	mineraalarm, bruin, zeggeveen, Opm.: hrizontale riet laagjes		
510 - 520	veen	mineraalarm, bruin, zeggeveen		
520 - 530	veen	mineraalarm, zwart-bruin, Veen: zwak amorf, zeggeveen		
530 - 540	veen	mineraalarm, zwart-bruin, Veen: sterk amorf, zeggeveen, weinig riet, Opm.: #, iets kleiig		
540 - 550	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, riet, Opm.: #		
550 - 560	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, riet		
560 - 570	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, weinig hout		
570 - 580	veen	mineraalarm, donker-bruin, Veen: zwak amorf, rietveen, zegge, weinig riet		
580 - 590	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, weinig riet		
590 - 600	geen monster	Opm.: #		
600 - 610	veen	mineraalarm, donker-geel-bruin, Veen: zwak amorf, rietveen, veel riet, Opm.: #		
610 - 620	veen	mineraalarm, donker-geel-bruin, Veen: zwak amorf, rietveen, veel riet		
620 - 630	veen	mineraalarm, bruin, Veen: matig amorf, rietveen		
630 - 640	veen	mineraalarm, bruin, Veen: matig amorf, rietveen		
640 - 650	veen	mineraalarm, grijs-bruin, Veen: matig amorf, rietveen, Opm.: erg nat		
650 - 660	veen	mineraalarm, grijs-bruin, Veen: sterk amorf, weinig zegge, Opm.: #, erg nat		
660 - 670	geen monster	Opm.: #		
670 - 680	veen	zwak kleiig, bruin, Veen: sterk amorf		
680 - 690	veen	mineraalarm, bruin, weinig riet		
690 - 695	klei	sterk siltig, grijs, Opm.: in het midden bruin humeus laagje 5mm, daar boven bruin-grijs h2, foto beschikbaar		
695 - 700	veen	zwak kleiig, bruin, veel kleibrokjes		
700 - 710	veen	zwak kleiig, bruin, Veen: matig amorf, weinig riet		
710 - 720	veen	zwak kleiig, bruin, Veen: matig amorf, weinig hout, spoor riet		
720 - 730	veen	zwak kleiig, bruin, Veen: matig amorf, weinig hout, weinig riet		
730 - 740	veen	zwak kleiig, bruin, Veen: matig amorf, weinig hout, Opm.: #, Monster M5		
740 - 750	veen	sterk kleiig, grijs-bruin, Veen: sterk amorf, Opm.: #		
750 - 770	veen	sterk kleiig, grijs-bruin, Veen: sterk amorf, weinig riet, spoor hout, Opm.: Monster M6		
770 - 780	klei	sterk siltig, blauw-grijs, weinig bruine vlekken, spoor plantenresten, Opm.: Ca-0		
780 - 790	klei	sterk siltig, blauw-grijs, spoor plantenresten, Opm.: Ca-0		
790 - 800	klei	sterk siltig, blauw-grijs, spoor plantenresten, Opm.: Ca-0		
800 - 810	klei	sterk siltig, blauw-grijs, riet, Opm.: Ca-0, heel licht humeus		
810 - 820	klei	sterk siltig, zwak humeus, bruin-grijs, weinig plantenresten, Opm.: # Ca-0		
820 - 830	klei	sterk siltig, zwak humeus, bruin-grijs, spoor plantenresten, Opm.: #, Ca-0		
830 - 840	klei	sterk siltig, zwak humeus, bruin-grijs, spoor hout, Opm.: Ca-0		
840 - 850	klei	sterk siltig, zwak humeus, bruin-grijs, spoor hout, Opm.: Ca-0		
850 - 860	klei	sterk siltig, zwak humeus, bruin-grijs, Opm.: #, Ca-0		
860 - 890	geen monster	Opm.: wel doorheen te komen, maar afdraaien gaat niet		

Universiteit Utrecht

B008

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 108024
Y-coordinaat (m)	: 446609
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: -176
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 960
Datum boring	: 6-2-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Pleintje op kruising Jan Philipsweg en Bosweg, in kleine boomspiegel van gerooide boom.

Boormethode

Diepte (cm)	Omschrijving
0 - 150	Edelmanboring
150 - 960	Guts

Lithologie

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 20	zand	uiterst siltig, matig humeus, grijs-bruin, weinig wortelresten, Schelpen: spoor schelpmateriaal		1
20 - 30	zand	uiterst siltig, matig humeus, grijs-bruin, weinig wortelresten, spoor hout, Opm.: kiezeltje		1
30 - 40	zand	zwak siltig, bruin-geel, Zand: matig grof, weinig hout, spoor wortelresten	210-300	1
40 - 50	zand	sterk siltig, geel-bruin, Schelpen: spoor schelpmateriaal		1
50 - 60	zand	sterk siltig, sterk humeus, bruin, spoor hout, Schelpen: spoor schelpmateriaal		1
60 - 70	zand	sterk siltig, donker-bruin-grijs, Opm.: boven bruin		2
70 - 80	zand	sterk siltig, sterk humeus, zwart-bruin, weinig wortelresten, spoor houtskool		2
80 - 90	zand	uiterst siltig, sterk humeus, zwart-grijs		2
90 - 100	zand	matig siltig, sterk humeus, zwart-grijs		2
100 - 110	zand	matig siltig, sterk grindig, sterk humeus, zwart-grijs, veel kalkconcreties, Opm.: onderin grind en baksteen		2
110 - 120	zand	sterk siltig, sterk humeus, zwart-grijs, veel kalkconcreties		2
120 - 130	zand	sterk siltig, sterk humeus, zwart-grijs, spoor baksteen		2
130 - 140	zand	uiterst siltig, sterk humeus, zwart-grijs, Schelpen: spoor schelpmateriaal, spoor baksteen		
140 - 150	zand	uiterst siltig, sterk humeus, donker-grijs-bruin		
150 - 160	klei	uiterst siltig, sterk humeus, donker-grijs-bruin, Opm.: #, boven zandig		
160 - 170	klei	sterk siltig, sterk humeus, donker-grijs-bruin		
170 - 180	veen	sterk kleiig, donker-bruin, spoor kalkconcreties, Opm.: Monster M1		
180 - 190	veen	sterk kleiig, donker-bruin, weinig plantenresten, Schelpen: spoor schelpmateriaal, veel veenbrokjes, Opm.: 3		
190 - 200	veen	mineraalarm, bruin, Veen: sterk amorf, spoor hout, Opm.: #		
200 - 210	veen	mineraalarm, grijs-bruin, Veen: sterk amorf, weinig hout		
210 - 220	klei	sterk siltig, matig humeus, grijs, veel bruine vlekken, spoor plantenresten, Opm.: #		
220 - 230	geen monster	Opm.: #		
230 - 240	veen	zwak kleiig, donker-grijs-bruin, Veen: sterk amorf, spoor plantenresten		
240 - 250	veen	zwak kleiig, donker-grijs-bruin, Veen: sterk amorf, spoor plantenresten, Opm.: brokje Ks3 2cm		
250 - 260	klei	sterk siltig, matig humeus, bruin-grijs, weinig plantenresten, spoor veenbrokjes		
260 - 270	klei	sterk siltig, matig humeus, bruin-grijs, weinig bruine vlekken, spoor plantenresten, Opm.: #		
270 - 280	geen monster	Opm.: #		
280 - 290	klei	sterk siltig, matig humeus, bruin-grijs, weinig veenbrokjes		
290 - 300	veen	zwak kleiig, grijs-bruin, Veen: matig amorf, weinig plantenresten		
300 - 310	veen	zwak kleiig, bruin, Veen: matig amorf, weinig plantenresten		
310 - 320	veen	zwak kleiig, bruin, Veen: matig amorf, weinig plantenresten, Opm.: mossel		
320 - 330	veen	mineraalarm, bruin, Veen: matig amorf, zegge, Opm.: blokje blauwgrijze klei 2cm		
330 - 340	veen	mineraalarm, bruin, Veen: matig amorf, bosveen, hout		

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B008

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
340 - 350	veen	mineraalarm, bruin, Veen: matig amorf, zegge, Opm.: # rode wortel		
350 - 360	veen	mineraalarm, rood-bruin, Veen: matig amorf, veel zegge, spoor riet, spoor hout		
360 - 370	veen	mineraalarm, rood-bruin, Veen: matig amorf, plantenresten		
370 - 380	veen	mineraalarm, rood-bruin, Veen: matig amorf, plantenresten, weinig hout		
380 - 390	veen	mineraalarm, rood-bruin, Veen: matig amorf, plantenresten, weinig riet, Opm.: # onderin 3cm hout		
390 - 400	geen monster	Opm.: #		
400 - 410	hout	rood		
410 - 420	veen	mineraalarm, bruin, Veen: sterk amorf, zeggeveen, Opm.: plaatje riet		
420 - 440	veen	mineraalarm, bruin, zeggeveen, spoor riet		
440 - 450	veen	mineraalarm, bruin, Veen: matig amorf, zeggeveen, weinig riet		
450 - 460	veen	mineraalarm, bruin, Veen: sterk amorf, zeggeveen, Opm.: #		
460 - 470	veen	mineraalarm, donker-bruin, Veen: sterk amorf, zeggeveen, weinig hout, Opm.: #		
470 - 480	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, spoor houtskool		
480 - 490	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, weinig hout, Opm.: horizontaal laagje riet		
490 - 500	veen	mineraalarm, donker-bruin, spoor riet		
500 - 520	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, spoor hout, Opm.: Monster M2 op z= 520		
520 - 530	veen	mineraalarm, geel-bruin, rietveen, weinig riet		
530 - 540	veen	mineraalarm, geel-bruin, rietveen, veel riet, Opm.: #		
540 - 550	geen monster	Opm.: #, erg zacht veen, 10cm overschoten		
550 - 560	veen	mineraalarm, geel-bruin, rietveen, Opm.: laagjes riet		
560 - 570	veen	mineraalarm, geel-bruin, Veen: matig amorf, rietveen, weinig houtskool		
570 - 580	veen	zwak kleiig, donker-bruin, Veen: matig amorf		
580 - 590	veen	mineraalarm, bruin, Veen: matig amorf, rietveen		
590 - 600	veen	sterk kleiig, bruin, veel riet		
600 - 610	veen	sterk kleiig, bruin		
610 - 620	veen	sterk kleiig, grijs-bruin, weinig riet		
620 - 630	veen	sterk kleiig, bruin, hout, Opm.: #, takjes		
630 - 631	klei	sterk siltig, bruin-grijs, Opm.: #		
631 - 640	veen	sterk kleiig, bruin, Veen: matig amorf		
640 - 650	veen	sterk kleiig, bruin, plantenresten, houtskool		
650 - 670	veen	sterk kleiig, bruin, plantenresten		
670 - 680	veen	sterk kleiig, bruin, weinig hout		
680 - 690	veen	sterk kleiig, bruin-grijs, plantenresten, weinig hout		
690 - 700	veen	sterk kleiig, grijs-bruin, Veen: sterk amorf, Opm.: Monster M3		
700 - 710	veen	sterk kleiig, grijs-bruin, plantenresten, weinig hout, weinig kleibrokjes, Opm.: #		
710 - 720	veen	sterk kleiig, bruin, Veen: matig amorf, plantenresten, hout, Opm.: #, scherpe overgang naar klei onderaan		
720 - 730	klei	sterk siltig, matig humeus, bruin-grijs, plantenresten, weinig riet, Opm.: Ca-0		
730 - 740	klei	sterk siltig, blauw-grijs, spoor wortelresten, Opm.: Ca-0		
740 - 750	klei	uiterst siltig, blauw-grijs, spoor zwarte vlekken, spoor wortelresten, Opm.: Ca-0		
750 - 760	klei	uiterst siltig, blauw-grijs, spoor zwarte vlekken		2
760 - 770	klei	uiterst siltig, blauw-grijs, spoor zwarte vlekken, Opm.: #		2
770 - 790	klei	uiterst siltig, blauw-grijs, weinig zwarte vlekken		1
790 - 810	klei	matig zandig, blauw-grijs, weinig plantenresten		2
810 - 820	klei	uiterst siltig, blauw-grijs		1
820 - 830	klei	uiterst siltig, zwak humeus, licht-bruin-grijs		1
830 - 840	klei	uiterst siltig, zwak humeus, licht-bruin-grijs, Opm.: Ca-0		
840 - 850	klei	uiterst siltig, licht-bruin-grijs, Opm.: #, Ca-0		
850 - 860	klei	sterk siltig, blauw-grijs, weinig zwarte vlekken, Opm.: #, Ca-0		
860 - 870	klei	uiterst siltig, blauw-grijs, Opm.: Ca-0, zwarte humeuze band van 0.5cm		
870 - 890	klei	uiterst siltig, blauw-grijs		2
890 - 910	klei	matig zandig, blauw-grijs		2
910 - 930	klei	uiterst siltig, blauw-grijs, Opm.: #		2
930 - 940	klei	uiterst siltig, blauw-grijs, Opm.: #		2
940 - 950	klei	uiterst siltig, blauw-grijs		2
950 - 960	zand	zwak siltig, blauw-grijs, Zand: zeer grof, Opm.: #	300-420	2

Universiteit Utrecht

B009

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 107875
Y-coordinaat (m)	: 446263
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: -155
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 730
Datum boring	: 6-2-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Da Costakade in het gras tussen parkeerplekken en het water.

Boormethode

Diepte (cm)	Omschrijving
0 - 110	Edelmanboring
110 - 730	Guts

Lithologie

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 20	klei	sterk zandig, sterk humeus, donker-bruin, veel wortelresten		
20 - 30	klei	sterk zandig, sterk humeus, donker-bruin, veel wortelresten, weinig ijzeroxide, Opm.: brok Ks3		
30 - 40	klei	matig zandig, sterk humeus, donker-bruin, weinig wortelresten, weinig ijzeroxide, Opm.: brok Ks3		
40 - 50	klei	matig zandig, sterk humeus, donker-bruin, veel zwarte vlekken, weinig wortelresten, Schelpen: spoor schelpmateriaal, weinig ijzeroxide, spoor baksteen, Opm.: kiezel		
50 - 60	klei	matig zandig, sterk humeus, zwart, weinig wortelresten, Schelpen: schelpmateriaal, Opm.: kiezel, mossel		
60 - 70	klei	sterk zandig, sterk humeus, zwart, weinig bruine vlekken, weinig wortelresten		
70 - 80	klei	sterk zandig, sterk humeus, zwart, weinig bruine vlekken, weinig wortelresten, Opm.: kiezels		
80 - 90	klei	sterk siltig, sterk humeus, zwart-grijs, weinig wortelresten, Opm.: kiezels		
90 - 100	klei	sterk siltig, sterk humeus, zwart-grijs, weinig wortelresten, Opm.: kiezels		
100 - 110	klei	sterk siltig, zwak humeus, donker-grijs, spoor baksteen		
110 - 120	klei	uiterst siltig, zwak humeus, blauw-grijs, Opm.: #, stuk, vlekkerig		
120 - 130	klei	uiterst siltig, matig humeus, bruin-grijs, Opm.: stuk, vlekkerig		
130 - 140	klei	uiterst siltig, matig humeus, bruin-grijs, Opm.: #, stuk, vlekkerig		
140 - 150	geen monster	Opm.: #		
150 - 160	klei	uiterst siltig, matig humeus, donker-bruin-grijs		
160 - 170	klei	uiterst siltig, matig humeus, donker-bruin-grijs, weinig houtskool		
170 - 180	klei	uiterst siltig, matig humeus, donker-bruin-grijs, weinig houtskool		
180 - 190	klei	sterk siltig, grijs, weinig gele vlekken, Opm.: #, ijzer? or zone?		
190 - 200	klei	sterk siltig, grijs, weinig gele vlekken, Opm.: #, ijzer? or zone?		
200 - 210	veen	zwak kleiig, bruin, Veen: matig amorf, weinig plantenresten, weinig hout		
210 - 220	veen	mineraalarm, bruin, Veen: matig amorf, bosveen		
220 - 250	veen	mineraalarm, bruin, Veen: matig amorf, bosveen, veel hout, Opm.: # Monster M1 op z=240		
250 - 260	geen monster	Opm.: #		
260 - 270	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, veel hout, Opm.: #		
270 - 300	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, veel hout, Opm.: onderste 10cm erg nat		
300 - 310	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, veel hout		
310 - 330	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, veel hout, Opm.: laagje riet		
330 - 340	veen	mineraalarm, rood-bruin, Veen: zwak amorf, bosveen, veel hout, Opm.: #		
340 - 350	veen	mineraalarm, rood-bruin, Veen: zwak amorf, zeggeveen, Opm.: #		
350 - 360	veen	mineraalarm, donker-bruin, zeggeveen, spoor riet		
360 - 370	veen	mineraalarm, donker-bruin, zeggeveen, weinig riet		
370 - 400	veen	mineraalarm, bruin, zeggeveen, weinig riet, spoor hout		
400 - 420	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, Opm.: #		
420 - 430	veen	mineraalarm, bruin, Veen: matig amorf, zeggeveen, spoor riet, weinig hout, Opm.: #		
430 - 440	veen	mineraalarm, bruin, zeggeveen, weinig riet, weinig hout, weinig houtskool		

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
440 - 450	veen	mineraalarm, donker-bruin, zeggeveen, weinig riet, weinig hout, weinig houtskool		
450 - 460	veen	mineraalarm, donker-bruin, zeggeveen, weinig riet, weinig hout, Opm.: rood hout		
460 - 470	veen	mineraalarm, donker-bruin, zeggeveen, weinig riet		
470 - 480	veen	mineraalarm, donker-bruin, zeggeveen, Opm.: Monster M2		
480 - 490	veen	mineraalarm, donker-bruin, zeggeveen, weinig hout, spoor riet		
490 - 500	veen	mineraalarm, donker-bruin, zeggeveen, Opm.: #		
500 - 510	veen	mineraalarm, donker-bruin, Veen: sterk amorf, zeggeveen, riet, Opm.: #, rood hout, erg nat		
510 - 530	veen	mineraalarm, donker-bruin, zeggeveen, Opm.: rood hout		
530 - 540	veen	mineraalarm, donker-bruin, rietveen, veel riet, Opm.: rood hout		
540 - 550	veen	mineraalarm, donker-bruin, rietveen		
550 - 570	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, Opm.: #		
570 - 580	veen	mineraalarm, bruin, Veen: matig amorf, plantenresten, Opm.: #		
580 - 590	veen	mineraalarm, bruin, Veen: matig amorf, veel riet		
590 - 600	veen	mineraalarm, bruin, Veen: matig amorf, veel riet, weinig houtskool		
600 - 610	veen	mineraalarm, bruin, Veen: matig amorf, weinig hout, weinig riet		
610 - 620	veen	mineraalarm, bruin, Veen: matig amorf, weinig riet, veel hout, Opm.: bovenin 2cm hout		
620 - 630	veen	mineraalarm, bruin, Veen: matig amorf, weinig riet		
630 - 632	klei	matig siltig, grijs		
632 - 640	veen	zwak kleiig, bruin, Opm.: kleilaagje 2cm		
640 - 650	veen	zwak kleiig, bruin, Opm.: #		
650 - 660	veen	zwak kleiig, bruin, hout, Opm.: #		
660 - 670	veen	zwak kleiig, bruin, hout, riet		
670 - 680	veen	sterk kleiig, grijs-bruin, hout, riet		
680 - 700	veen	sterk kleiig, grijs-bruin, spoor hout		
700 - 710	klei	sterk siltig, matig humeus, licht-bruin-grijs, plantenresten, weinig riet, Opm.: Ca-0		
710 - 720	klei	sterk siltig, zwak humeus, blauw-grijs, plantenresten, weinig riet, Opm.: Ca-0		
720 - 730	klei	sterk siltig, zwak humeus, blauw-grijs, weinig hout, Opm.: #, Ca-0		

Universiteit Utrecht

B010

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 107659
Y-coordinaat (m)	: 445916
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: -177
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 650
Datum boring	: 6-2-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Grasveldje tussen kruising Hoefbladstraat en Hoornbloemstraat.

Boormethode

Diepte (cm)	Omschrijving
0 - 120	Edelmanboring
120 - 650	Guts

Lithologie

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 30	zand	sterk siltig, sterk humeus, zwart-bruin, wortelresten, Opm.: Ca-0, sporen geel zand		
30 - 40	zand	sterk siltig, sterk humeus, zwart-bruin, wortelresten, Opm.: Ca-0, kiezel		
40 - 50	zand	sterk siltig, sterk humeus, zwart-bruin, wortelresten, Schelpen: schelpmateriaal, Opm.: Ca-0, kiezel		
50 - 80	zand	sterk siltig, sterk humeus, zwart-bruin, Schelpen: schelpmateriaal, Opm.: Ca-0		
80 - 90	zand	sterk siltig, sterk humeus, zwart-bruin, Opm.: CA-0		
90 - 100	zand	sterk siltig, sterk humeus, zwart-bruin, veel zwarte vlekken, Opm.: Ca-0		
100 - 120	zand	sterk siltig, sterk humeus, zwart-bruin, Opm.: Ca-0		
120 - 130	zand	sterk siltig, sterk humeus, zwart-bruin, Opm.: #, Ca-0		
130 - 140	klei	uiterst siltig, sterk humeus, zwart-bruin, Opm.: plastic		
140 - 150	zand	zwak siltig, donker-grijs, Zand: matig grof	210-300	
150 - 160	klei	uiterst siltig, sterk humeus, licht-bruin-grijs, veel zwarte vlekken, Opm.: #		
160 - 170	veen	sterk kleiig, donker-bruin-grijs, Veen: sterk amorf, Opm.: #		
170 - 180	klei	sterk siltig, sterk humeus, grijs-bruin, Opm.: #		
180 - 190	veen	sterk kleiig, bruin, veel zwarte vlekken		
190 - 200	klei	sterk siltig, sterk humeus, licht-bruin-grijs, Opm.: #, brokje plr		
200 - 220	zand	matig siltig, donker-grijs, Zand: zeer grof, Opm.: #, kiezels, mogelijk terug gestroomd?	300-420	
220 - 250	klei	uiterst siltig, matig humeus, donker-grijs		
250 - 260	klei	sterk siltig, grijs, veel hout, Opm.: #		
260 - 270	veen	mineraalarm, bruin, Veen: matig amorf, Opm.: #		
270 - 280	veen	mineraalarm, bruin, Veen: matig amorf, bosveen, veel hout		
280 - 290	veen	mineraalarm, bruin, Veen: matig amorf, bosveen, weinig riet, veel hout		
290 - 300	veen	mineraalarm, bruin, Veen: matig amorf, bosveen, spoor riet, Opm.: onderin veel hout		
300 - 310	veen	mineraalarm, bruin, Veen: matig amorf, bosveen, spoor riet, veel hout		
310 - 320	hout	bruin		
320 - 330	veen	zwak kleiig, bruin		
330 - 340	veen	mineraalarm, bruin, bosveen, Opm.: #		
340 - 350	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, Opm.: #		
350 - 360	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen		
360 - 370	veen	mineraalarm, bruin, rietveen, Opm.: Monster M1		
370 - 420	veen	mineraalarm, bruin, zeggeveen, weinig riet, Opm.: #, onderste 10cm nat en AV1		
420 - 430	veen	mineraalarm, bruin, zeggeveen, veel riet, Opm.: #, horizontale riet laagjes		
430 - 440	veen	mineraalarm, bruin, zeggeveen, spoor riet		
440 - 500	veen	mineraalarm, bruin, zeggeveen, weinig riet, Opm.: #, onderste 30cm AV2		
500 - 510	veen	mineraalarm, bruin, Veen: sterk amorf, plantenresten, Opm.: #		
510 - 520	veen	mineraalarm, bruin, Veen: matig amorf, rietveen		
520 - 530	veen	mineraalarm, bruin, Veen: matig amorf, plantenresten, riet, Opm.: rood hout		
530 - 540	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, Opm.: Monster M2		
540 - 550	veen	mineraalarm, bruin, Veen: matig amorf, rietveen		
550 - 560	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen		
560 - 570	veen	mineraalarm, bruin, zeggeveen, Opm.: #		

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
570 - 580	veen	mineraalarm, bruin, hout, wortelresten, Opm.: #		
580 - 590	veen	mineraalarm, bruin, weinig riet		
590 - 600	veen	zwak kleiig, bruin		
600 - 610	klei	sterk siltig, zwak humeus, donker-grijs, Opm.: Ca-0, verticale plr, bodem vorming, Monster M3		
610 - 620	klei	sterk siltig, blauw-grijs, spoor zwarte vlekken, spoor plantenresten, Opm.: Ca-0		
620 - 650	klei	sterk siltig, blauw-grijs, spoor plantenresten, Opm.: #. Ca-0		

Universiteit Utrecht

B011

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 108841
Y-coordinaat (m)	: 447295
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: 1
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 790
Datum boring	: 8-2-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Houtmansplantsoen 2 in het gras langs de singel. ongeveer 60 cm boven waterpeil. laag van Wijchen niet bereikt

Boormethode

Diepte (cm)	Omschrijving
0 - 120	Edelmanboring
120 - 150	Guts
150 - 250	Van der Staay boring
250 - 790	Guts

Lithologie

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 20	zand	zwak siltig, licht-grijs-bruin, Zand: matig grof, weinig wortelresten	210-300	1
20 - 30	zand	zwak siltig, zwak grindig, bruin, weinig wortelresten, spoor baksteen, Opm.: gemengd met geel zand		1
30 - 40	zand	zwak siltig, bruin, veel wortelresten		1
40 - 50	klei	sterk siltig, bruin, veel wortelresten, weinig baksteen, Opm.: kiezels		
50 - 60	klei	sterk siltig, bruin, weinig kalkconcreties		
60 - 70	klei	sterk siltig, zandig, bruin, weinig kalkconcreties		
70 - 80	klei	sterk siltig, zandig, donker-grijs-bruin, weinig kalkconcreties		
80 - 90	klei	uiterst siltig, zandig, donker-grijs-bruin, weinig kalkconcreties		
90 - 100	klei	uiterst siltig, zandig, donker-grijs-bruin, veel kalkconcreties		
100 - 110	klei	uiterst siltig, zandig, sterk grindig, donker-grijs, Opm.: nat		
110 - 120	klei	uiterst siltig, zandig, sterk grindig, donker-grijs, Opm.: nat		
120 - 130	geen monster	Opm.: #		
130 - 140	geen monster			
140 - 150	zand	matig siltig, donker-grijs, Zand: matig grof, Opm.: #	210-300	
150 - 160	zand	sterk siltig, donker-grijs, Zand: matig grof, Opm.: $	210-300	1
160 - 170	zand	uiterst siltig, grijs, Zand: matig grof, Schelpen: spoor schelpmateriaal	210-300	1
170 - 180	zand	uiterst siltig, grijs, Zand: matig grof	210-300	1
180 - 190	zand	uiterst siltig, grijs, Zand: matig grof, veel hout	210-300	1
190 - 200	zand	zwak siltig, bruin-grijs, Zand: matig grof, Schelpen: spoor schelpmateriaal, weinig baksteen, Opm.: $	210-300	1
200 - 210	zand	uiterst siltig, licht-bruin-grijs, Zand: matig grof, Opm.: $, bruin bandje	210-300	1
210 - 220	zand	uiterst siltig, licht-bruin-grijs, Zand: matig grof	210-300	1
220 - 230	zand	uiterst siltig, grijs, Zand: matig grof	210-300	1
230 - 240	veen	sterk kleiig, zwart, Veen: sterk amorf, Opm.: $, onder Zs4		1
240 - 250	zand	zwak siltig, sterk grindig, donker-bruin-grijs, weinig baksteen, Opm.: $$		1
250 - 260	leem	sterk zandig, donker-grijs, Opm.: #, Ca-0		
260 - 270	klei	uiterst siltig, zandig, zwak humeus, donker-grijs, Opm.: Ca-0, nat		
270 - 280	klei	uiterst siltig, zwart-grijs, Opm.: brok cement 4cm		1
280 - 290	klei	uiterst siltig, zwart-grijs, weinig bruine vlekken		1
290 - 300	veen	zwak kleiig, zwart, Veen: sterk amorf		1
300 - 310	veen	sterk kleiig, zwart-grijs, Veen: sterk amorf, veel hout, weinig baksteen		1
310 - 320	geen monster	Opm.: #		
320 - 330	klei	sterk siltig, donker-grijs, Opm.: #		1
330 - 340	klei	sterk siltig, donker-grijs, hout, Opm.: onder brgr		1
340 - 360	klei	uiterst siltig, matig humeus, bruin-grijs, weinig plantenresten, Opm.: #		1
360 - 370	klei	sterk siltig, matig humeus, bruin-grijs, weinig plantenresten, Opm.: # heel slakje, Monster M1		

Universiteit Utrecht

B011

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
370 - 380	klei	sterk siltig, matig humeus, bruin-grijs, weinig plantenresten, Opm.: #		
380 - 390	klei	sterk siltig, sterk humeus, bruin-grijs, weinig plantenresten, Opm.: Monster M2		
390 - 400	veen	zwak kleiig, bruin, veel hout, Opm.: boven Ks3		
400 - 410	veen	mineraalarm, bruin, veel hout, Opm.: 5cm hout		
410 - 420	veen	mineraalarm, bruin, hout, brokkelig, Opm.: #, compact		
420 - 430	geen monster	Opm.: #		
430 - 440	veen	mineraalarm, bruin, weinig hout		
440 - 460	veen	mineraalarm, bruin, veel hout, weinig riet		
460 - 470	veen	zwak kleiig, bruin, veel plantenresten		
470 - 480	veen	zwak kleiig, grijs-bruin, weinig plantenresten		
480 - 500	veen	sterk kleiig, grijs-bruin, Opm.: #, Monster M3 op z=490		
500 - 530	klei	sterk siltig, sterk humeus, licht-bruin-grijs, Opm.: # op z=510		
530 - 540	klei	sterk siltig, sterk humeus, licht-bruin-grijs, spoor plantenresten, Opm.: Monster M4		
540 - 560	klei	sterk siltig, sterk humeus, licht-bruin-grijs, spoor plantenresten, Opm.: #		
560 - 570	klei	sterk siltig, sterk humeus, licht-bruin-grijs, Opm.: #		
570 - 580	klei	sterk siltig, sterk humeus, licht-bruin-grijs		
580 - 600	veen	sterk kleiig, bruin		
600 - 620	veen	mineraalarm, bruin, Veen: zwak amorf, veel hout, Opm.: Monster M5 op z=610		
620 - 640	veen	zwak kleiig, bruin, Veen: zwak amorf, veel hout, Opm.: #, Monster M6 op z=630		
640 - 650	klei	uiterst siltig, sterk humeus, bruin-grijs, Opm.: #, boven Vk1		
650 - 660	klei	uiterst siltig, sterk humeus, grijs-bruin, weinig hout, Opm.: kleine witte stipjes/concreties?		
660 - 670	klei	sterk siltig, sterk humeus, grijs-bruin, weinig hout, Opm.: kleine witte stipjes/concreties?, bandje met veel plr boven		
670 - 680	klei	uiterst siltig, sterk humeus, grijs-bruin, weinig hout, Opm.: kleine witte stipjes/concreties?		
680 - 690	klei	uiterst siltig, sterk humeus, grijs-bruin, weinig hout, Opm.: #, onder 3cm rietveen		
690 - 700	veen	mineraalarm, bruin, rietveen, veel riet, Opm.: #		
700 - 720	veen	mineraalarm, bruin, rietveen, veel riet, Opm.: #		
720 - 730	veen	mineraalarm, bruin, rietveen, Opm.: #		
730 - 750	veen	mineraalarm, bruin, rietveen, veel riet		
750 - 760	klei	sterk siltig, sterk humeus, bruin-grijs, veel plantenresten		
760 - 770	veen	zwak kleiig, grijs-bruin, veel riet, Opm.: #		
770 - 780	veen	zwak kleiig, grijs-bruin, veel riet, Opm.: #, Monster M7		
780 - 790	veen	zwak kleiig, grijs-bruin, veel riet, Opm.: #		

Universiteit Utrecht

B012

Coordinaatsysteem	: Rijksdriehoeksmeting
X-coordinaat (m)	: 106731
Y-coordinaat (m)	: 445711
Referentievlak	: Normaal Amsterdams Peil
Maaiveld (cm)	: -230
Bepaling maaiveldhoogte	: Actueel Hoogtebestand Nederl.
Diepte van de boring (cm)	: 1100
Datum boring	: 12-4-2017
Plaatsnaam	: Gouda
Organisatie	: Universiteit Utrecht
Boormeester	: Simon van Laarhoven
Vertrouwelijkheid	: Openbaar
Opmerkingen	: Zuidwesterlijke hoek van golfbaan IJsselweide. Relatief onbelast veen. Dikke pakketten uniform veen.

Boormethode

Diepte (cm)	Omschrijving
0 - 150	Edelmanboring
150 - 1100	Guts

Lithologie

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
0 - 20	veen	sterk kleiig, donker-bruin, Veen: sterk amorf, veel wortelresten, Opm.: verland, beetje zandig		
20 - 30	veen	sterk kleiig, donker-bruin, Veen: sterk amorf, veel wortelresten, Opm.: verland		
30 - 40	veen	sterk kleiig, donker-bruin, Veen: sterk amorf, veel wortelresten, Opm.: verland		
40 - 50	veen	sterk kleiig, donker-bruin, Veen: sterk amorf, veel wortelresten, weinig houtskool, Opm.: verland		
50 - 60	veen	sterk kleiig, donker-bruin, Veen: sterk amorf, veel wortelresten, weinig hout, Opm.: verland		
60 - 70	veen	sterk kleiig, donker-bruin, Veen: sterk amorf, veel wortelresten, weinig hout, Opm.: natter		
70 - 80	veen	zwak kleiig, bruin, Veen: sterk amorf, weinig hout		
80 - 90	veen	zwak kleiig, bruin, Veen: sterk amorf, veel hout		
90 - 100	veen	mineraalarm, bruin, Veen: sterk amorf, veel hout		
100 - 110	veen	mineraalarm, bruin, Veen: sterk amorf, veel hout		
110 - 120	veen	mineraalarm, bruin, bosveen, veel hout, weinig riet, Opm.: #, erg slap		
120 - 130	veen	mineraalarm, bruin, Veen: matig amorf, bosveen, veel hout, weinig riet, Opm.: kevertje		
130 - 140	veen	mineraalarm, bruin, Veen: matig amorf, bosveen, veel hout, weinig riet, Opm.: ongecompacteerd, weinig vezels, fijne matrix		
140 - 150	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, weinig hout, veel riet, Opm.: ongecompacteerd, weinig vezels, fijne matrix		
150 - 160	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, spoor hout, veel riet, Opm.: #, ongecompacteerd, weinig vezels, fijne matrix		
160 - 170	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, weinig riet, Opm.: #, ongecompacteerd, weinig vezels, fijne matrix		
170 - 180	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, weinig riet, Opm.: ongecompacteerd, weinig vezels, fijne matrix		
180 - 200	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, veel riet, Opm.: ongecompacteerd, weinig vezels, fijne matrix		
200 - 210	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, weinig hout, Opm.: ongecompacteerd, weinig vezels, fijne matrix		
210 - 240	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, weinig riet, Opm.: #, ongecompacteerd, weinig vezels, fijne matrix		
240 - 250	veen	mineraalarm, bruin, veel hout, Opm.: #		
250 - 260	veen	mineraalarm, bruin, veel hout, weinig riet		
260 - 270	veen	mineraalarm, donker-bruin, Veen: zwak amorf, rietveen, zeggeveen, veel riet, veel zegge, Opm.: vezelig		
270 - 310	veen	mineraalarm, donker-bruin, Veen: zwak amorf, rietveen, zeggeveen, Opm.: vezelig		
310 - 320	geen monster	Opm.: #		
320 - 330	veen	mineraalarm, bruin, rietveen, riet, Opm.: #, vezelig		
330 - 340	veen	mineraalarm, bruin, rietveen, Opm.: vezelig		
340 - 350	veen	mineraalarm, bruin, rietveen, galigaan, Opm.: vezelig		

Diepte (cm)	Grondsoort	Omschrijving	Ca	M63
350 - 360	veen	mineraalarm, bruin, rietveen, Opm.: vezelig		
360 - 390	veen	mineraalarm, bruin, zeggeveen, weinig hout, weinig riet, Opm.: vezelig		
390 - 400	veen	mineraalarm, bruin, zeggeveen, weinig hout, weinig riet, galigaan, Opm.: #, vezelig		
400 - 410	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, weinig riet, Opm.: #, vezelig		
410 - 420	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, weinig riet, galigaan, Opm.: vezelig		
420 - 430	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, veel riet, galigaan, Opm.: vezelig		
430 - 470	veen	mineraalarm, donker-bruin, Veen: matig amorf, zeggeveen, weinig riet, galigaan, Opm.: vezelig		
470 - 480	geen monster	Opm.: #		
480 - 490	klei	zwak siltig, grijs, veel riet, Opm.: #		
490 - 500	veen	mineraalarm, donker-bruin, Veen: sterk amorf, hout		
500 - 510	veen	mineraalarm, bruin, Veen: sterk amorf, rietveen, veel riet		
510 - 530	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, weinig hout		
530 - 540	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, weinig riet		
540 - 550	veen	mineraalarm, bruin, Veen: matig amorf, rietveen, veel riet, galigaan		
550 - 560	veen	mineraalarm, bruin, Veen: zwak amorf, rietveen, veel riet, Opm.: #		
560 - 570	veen	mineraalarm, bruin, rietveen, veel riet, galigaan, Opm.: #		
570 - 586	veen	mineraalarm, bruin, rietveen, veel riet		
586 - 590	klei	zwak siltig, grijs, veel riet, Opm.: gelaagd		
590 - 600	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, veel riet, weinig hout		
600 - 610	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, veel riet		
610 - 620	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, veel riet, galigaan		
620 - 630	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, weinig riet, weinig zegge		
630 - 640	veen	mineraalarm, donker-bruin, Veen: matig amorf, rietveen, weinig riet, Opm.: #		
640 - 650	veen	mineraalarm, bruin, Veen: zwak amorf, weinig riet, houtskool, Opm.: #		
650 - 680	veen	mineraalarm, bruin, Veen: zwak amorf, veel riet		
680 - 690	veen	mineraalarm, bruin, Veen: sterk amorf, weinig riet, Opm.: weinig vezels		
690 - 700	veen	mineraalarm, bruin, weinig riet		
700 - 720	veen	mineraalarm, bruin, Opm.: #, enorm slap, Detritus, mogelijk iets kleiig		
720 - 730	veen	mineraalarm, donker-bruin, Veen: sterk amorf, weinig riet, weinig zegge, Opm.: #, enorm slap		
730 - 740	veen	mineraalarm, donker-bruin, Veen: sterk amorf, weinig riet, weinig zegge, Opm.: enorm slap		
740 - 770	veen	mineraalarm, donker-bruin, Veen: sterk amorf, weinig riet, weinig zegge, galigaan, Opm.: enorm slap		
770 - 800	veen	mineraalarm, donker-bruin, Veen: sterk amorf, weinig riet, weinig zegge, Opm.: #, enorm slap		
800 - 810	veen	mineraalarm, bruin, Veen: sterk amorf, plantenresten, Opm.: #, Detritus		
810 - 830	veen	mineraalarm, bruin, Veen: sterk amorf, plantenresten, Opm.: Detritus		
830 - 840	veen	zwak kleiig, bruin, Veen: matig amorf, plantenresten, Opm.: Detritus		
840 - 850	veen	sterk kleiig, grijs-bruin, Veen: matig amorf, veel riet, Opm.: detritus		
850 - 860	veen	zwak kleiig, bruin-grijs, Veen: zwak amorf, veel riet		
860 - 880	geen monster	Opm.: #		
880 - 890	veen	sterk kleiig, bruin-grijs, veel riet, Opm.: #		
890 - 900	veen	sterk kleiig, donker-grijs, veel riet, Opm.: erg kleiig met veel planten resten		
900 - 910	veen	sterk kleiig, zwart-grijs, veel riet, houtskool, Opm.: erg kleiig met veel planten resten, bodemvorming		
910 - 920	klei	zwak siltig, grijs, weinig riet, Opm.: vertikaal gelaagd riet		
920 - 940	klei	zwak siltig, grijs, weinig riet		
940 - 950	klei	zwak siltig, grijs, weinig riet, weinig houtskool		
950 - 960	klei	zwak siltig, grijs, weinig riet, Opm.: #		
960 - 970	klei	zwak siltig, grijs, weinig plantenresten, Opm.: #		
970 - 980	klei	zwak siltig, grijs, weinig plantenresten		
980 - 990	klei	zwak siltig, donker-grijs, weinig plantenresten, Opm.: bodem vorming		
990 - 1000	klei	sterk siltig, zandig, grijs, weinig donker-grijze vlekken, weinig plantenresten		
1000 - 1020	klei	sterk siltig, zandig, licht-grijs, weinig donker-grijze vlekken, spoor plantenresten		
1020 - 1030	klei	sterk siltig, zandig, licht-grijs, veel donker-grijze vlekken, spoor plantenresten, Opm.: bodempje		
1030 - 1040	klei	sterk siltig, zandig, licht-grijs, weinig donker-grijze vlekken, spoor plantenresten, Opm.: #		
1040 - 1050	klei	sterk siltig, zandig, licht-grijs, weinig donker-grijze vlekken, spoor plantenresten, Opm.: #		

Diepte (cm)	Grondsoort	Omschrijving	M63	Ca
1050 - 1090	klei	sterk siltig, zandig, licht-grijs, spoor plantenresten		
1090 - 1100	klei	uiterst siltig, zandig, licht-grijs, spoor plantenresten, Opm.: #		

Appendix 7: overview of the coordinates and sand-depth of all CPT data used to reconstruct the channel belts.

ID	X	Y	Depth [m]	ID	X	Y	Depth [m]
CPT000000000803	107972	447318	-16.00	S38A00388	108330	446326	-8.70
CPT000000001300	107031	445634	-12.31	S38A00402	107525	447910	-13.00
CPT000000001301	107312	446041	-12.67	S38A00411	106621	445850	-13.50
CPT000000007279	106825	445184	-13.15	S38A00418	109253	447704	-9.30
CPT000000007662	106996	445671	-12.01	S38A00419	107510	447516	-12.50
CPT000000007908	106720	445843	-17.34	S38A00427	109042	447056	-12.30
CPT000000019244	106795	445795	-15.85	S38A00464	107930	447362	-12.80
CPT000000019245	106823	445787	-15.95	S38A00486	108353	446972	-11.80
CPT000000019868	106793	445167	-8.50	S38A00497	107739	445731	-5.50
CPT000000019994	108059	447106	-13.59	S38A00498	108062	446065	-9.50
CPT000000029203	107930	447362	-12.90	S38A00500	108645	446676	-10.00
CPT000000036227	106923	446536	-14.09	S38A00501	108701	447372	-11.50
CPT000000036228	106887	446558	-14.15	S38A00502	108761	447274	-9.00
CPT000000036551	107105	445391	-8.12	S38A00506	108779	447077	-9.00
CPT000000036552	107255	445421	-8.17	S38A00526	107283	447155	-12.40
CPT000000036553	108323	446095	-8.25	S38A00531	108024	446862	-12.50
CPT000000036555	106956	445201	-8.76	S38A00538	108636	447632	-12.50
CPT000000036556	107050	445351	-7.98	S38A00539	108626	447651	-13.80
CPT000000036559	107360	445418	-8.85	S38A00541	108055	447395	-11.50
CPT000000036563	108099	445840	-8.90	S38A00543	108030	447470	-11.60
CPT000000036564	108160	445889	-9.03	S38A00552	109258	447477	-7.00
CPT000000036565	108462	446239	-7.36	S38A00591	106794	445182	-9.50
CPT000000036566	108608	446348	-10.21	S38A00609	108758	447293	-11.00
CPT000000036567	107780	445531	-8.65	S38A00610	108758	447293	-11.50
CPT000000036568	107942	445661	-8.78	S38A00612	108758	447293	-9.30
CPT000000036569	109261	446487	-13.48	S38A00615	108758	447293	-10.40
CPT000000036573	108816	446526	-9.30	S38A00617	108758	447293	-11.80
CPT000000036574	109168	446475	-11.26	S38A00618	108758	447293	-11.50
CPT000000036575	109252	446515	-15.40	S38A00619	108758	447293	-11.90
CPT000000036579	108083	445859	-9.09	S38A00628	108758	447295	-11.00
CPT000000046122	106806	446462	-13.87	S38A00629	108758	447295	-11.50
CPT000000046123	106782	446499	-14.47	S38A00630	108758	447295	-12.20
CPT000000072851	109179	446079	-11.50	S38A00631	108758	447295	-9.30
S38A00319	107009	445326	-8.50	S38A00633	108758	447295	-10.40
S38A00333	107962	446607	-11.30	S38A00683	109046	447603	-10.50
S38A00334	107491	446383	-12.50	S38A00684	109046	447603	-11.80
S38A00351	108780	447123	-8.70	S38A00687	108353	446972	-11.50
S38A00362	109247	446912	-13.90	S38A00692	108456	447525	-12.00
S38A00364	108342	446856	-11.20	S38A00693	108456	447525	-12.00
S38A00366	108453	447705	-11.40	S38A00696	108648	446983	-7.00
S38A00371	108274	447227	-12.00	S38A00716	108158	447803	-11.70
S38A00380	108443	446955	-10.00	S38A00717	107564	447418	-12.00
S38A00381	108664	447382	-11.40	S38A00718	107564	447418	-12.70
S38A00382	108422	447418	-12.70	S38A00719	108062	446065	-6.20
S38A00385	108344	447267	-13.30	S38A00720	108184	446158	-8.90

ID	X	Y	Depth [m]
S38A00721	108184	446158	-8.30
S38A00730	107411	447418	-11.70
S38A00731	107411	447418	-12.00
S38A00740	107851	446190	-10.00
S38A00742	108645	446676	-10.40
S38A00764	108497	446831	-10.00
S38A00765	108497	446831	-9.80
S38A00766	108495	446839	-8.80
S38A00767	108495	446835	-9.20
S38A00768	108490	446838	-10.00
S38A00769	108483	446838	-10.90
S38A00771	108486	446845	-10.80
S38A00772	108486	446845	-11.00
S38A00775	108796	447353	-8.50
S38A00776	108796	447353	-9.00
S38A00788	108354	447279	-12.40
S38A00800	108567	448002	-13.00
S38A00805	108722	446814	-8.60
S38A00806	108722	446814	-8.60
S38A00815	108447	447701	-11.40
S38A00816	108447	447701	-11.40
S38A00821	108634	447465	-11.00
S38A00837	107156	447099	-12.00
S38A00847	108342	446856	-11.50
S38A00865	108439	447708	-11.50
S38A00866	108439	447708	-11.30
S38A00867	108453	447705	-11.30
S38A00873	108005	447282	-13.70
S38A00874	108443	446955	-9.80
S38A00875	108664	447382	-11.00

IID	X	Y	Depth [m]
S38A00877	108433	447359	-11.10
S38A00883	107931	446631	-12.00
S38A00900	108330	446326	-7.00
S38A00901	108486	446709	-8.60
S38A00902	108487	446714	-8.80
S38A00903	108487	446714	-8.50
S38A00905	108558	447734	-13.00
S38A00907	108558	447734	-13.00
S38A00931	108344	447267	-13.60
S38A00937	107510	447516	-11.90
S38A00965	107295	446145	-12.80
S38A00972	109253	447704	-8.80
S38A00974	107671	446532	-12.80
S38A00981	108646	447703	-12.80
S38A00982	108646	447703	-13.00
S38A00985	108042	447396	-11.90
S38A00987	106621	445850	-14.50
S38A01023	108658	447658	-12.40
S38A01028	107417	446227	-13.00
S38A01029	107417	446227	-12.80
S38A01039	109258	447477	-7.50
S38A01102	107972	447318	-16.00
S38A01112	107009	445326	-8.50
S38A01117	106793	445167	-8.50
S38A01120	108059	447106	-13.60
S38A01142	106923	446536	-14.00
S38A01143	106887	446558	-14.20
S38A01150	106806	446462	-14.00
S38A01151	106782	446499	-14.00

Appendix 8: overview of initial model layers depths. A) Table indicating average depths implemented for each layer, before layer tweaking. B) Maps indicating the spatial differences in layer depth.

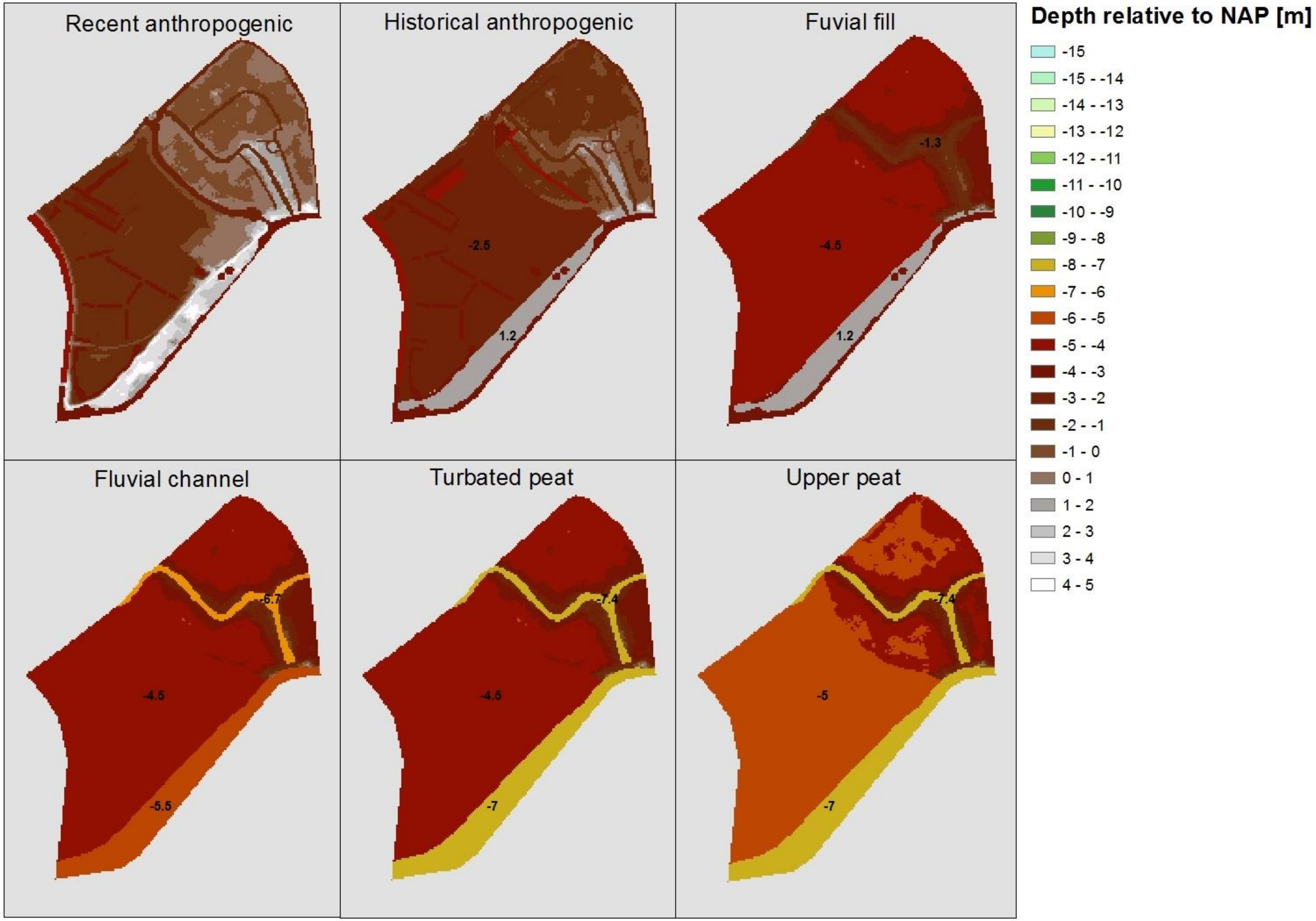
A.

Top depth* [m NAP] for:		Inner city	Korte Akkeren	Gouwe**	Hollandse IJssel***
		Regions distinguished at the surface			
Anthropogenic	Recent	AHN	AHN	AHN	AHN
	Historical	At 25 % of total anthropogenic layer [a]	-2.5 [b]	= AHN - 0.5 m	= "Top_Fill"
Fluvial	Channel-fill	Based on Van Dasselaar et al. (2013) (Figure 8)	-4.5	-1.3	1.2
	Bedding	= "Top_Fill"	= "Top_Fill"	-6.7 [c]	-5.5
Peat	Turbated	= "Top_Fill"	= "Top_Fill"	= "Top_LowerPeat"	= "Top_LowerPeat"
	Upper	= "Top_TurbatedPeat" – 0.5 m	= "Top_TurbatedPeat" – 0.5 m	= "Top_LowerPeat"	= "Top_LowerPeat"
	Waddinxveen flood-clay	-8 [d]	-8 [d]	= "Top_LowerPeat"	= "Top_LowerPeat"
	lower	-8.3 [d]	-8.3 [d]	-7.4 [c]	-7

Top depth* [m NAP] for:		Zuidplas	Gouderak	Pleistocene
		Regions distinguished based on channel belts		
Echteld****	Levee/floodplain deposits	-7.5	-9	-11.3
	Channel deposits (sand) [e]	-8.5	-11.3	= "Top_Wijchen"
Kreftenheye	Wijchen member	--	--	-11.8
	Channel deposits (sand) [f]	--	--	-12.8

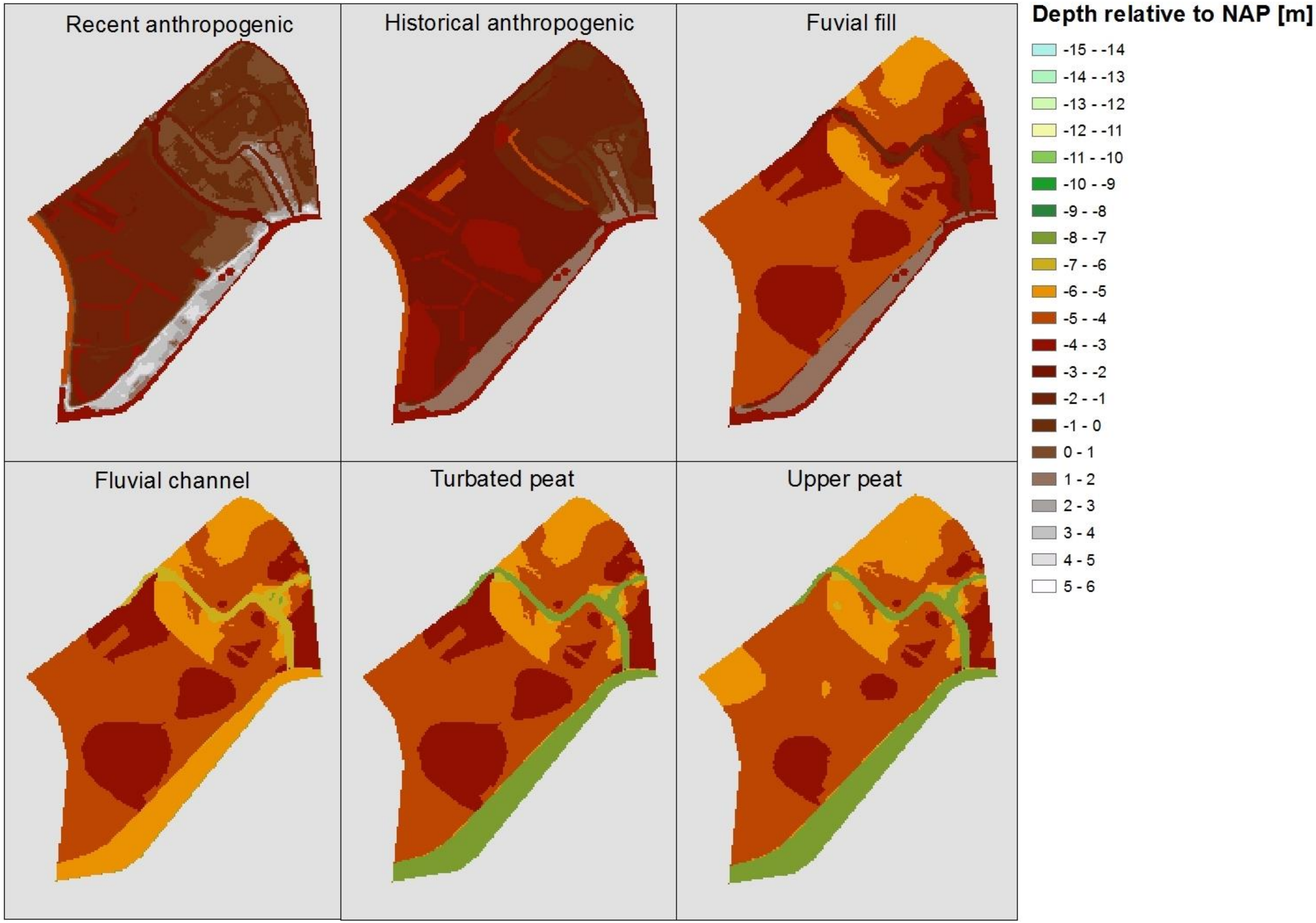
* if not stated otherwise, depths are based on the average layer depths observed from the constructed cross-sections (Addendum).
** superimposed on average layer depts.
*** based on core B38A0148 (DINOloket; TNO, 2014). Superimposed on average layer depts.
**** deposits from the Gouderak and Zuidplas channel belts merged into one model layer.
a) deeper at the demped canals "Raam" and "Nieuwe Haven", and at the archaeological excavation at "Verlorenkost". Depts of 4.20, 2.00 and 3.30 m-NAP, respectively. Based on archaeological cores 005 and 039, and new core B004, respectively.
b) thick industrial layer at newly constructed housing block at core B005A (4.20 m-NAP).
c) based on core 013.
d) not present above Zuidplas channel belt. Chosen to use only the "Upper peat" above this channel belt, as the Waddinxveen flood-clay is not present to distinguish between the two.
e) based on both cross-sections (Addendum) and CPTs (Cone Penetration Tests; TNO, 2014).
f) based on CPTs (TNO, 2014).
-- deeper than 15 m-NAP (maximum model depth).

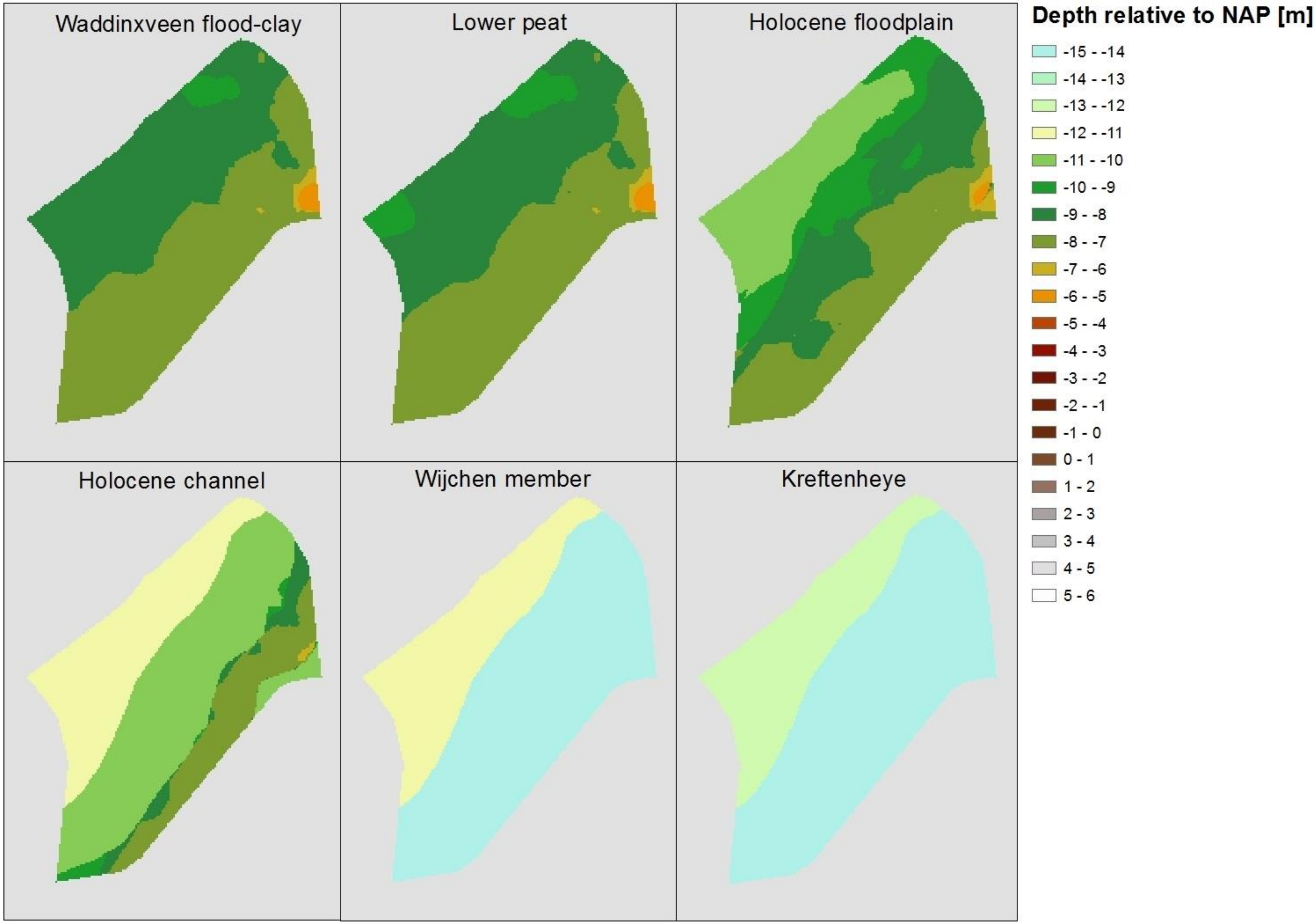
B.


Recent anthropogenic
Historical anthropogenic
Fuvial fill
Fluvial channel
Turbated peat
Upper peat
-2.5
1.2
-4.5
-1.3
1.2
-4.5
-6.7
-5.5
-4.5
-7.4
-7
-5
-7.4
-7
Depth relative to NAP [m]
-15
-15 - -14
-14 - -13
-13 - -12
-12 - -11
-11 - -10
-10 - -9
-9 - -8
-8 - -7
-7 - -6
-6 - -5
-5 - -4
-4 - -3
-3 - -2
-2 - -1
-1 - 0
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5


Waddinxveen flood-clay
-7.4
-8
-7.5
-7
Lower peat
-7.4
-8
-7.5
-7
Holocene floodplain
-11.3
-9
-7.5
Holocene channel
-11.3
-8.5
Wijchen member
-11.8
-15
Kreftenheye
-12.8
-15
Depth relative to NAP [m]
-15
-15 - -14
-14 - -13
-13 - -12
-12 - -11
-11 - -10
-10 - -9
-9 - -8
-8 - -7
-7 - -6
-6 - -5
-5 - -4
-4 - -3
-3 - -2
-2 - -1
-1 - 0
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5

Appendix 9: maps indicating the depths of the layers of the final 3D lithostratigraphic model.

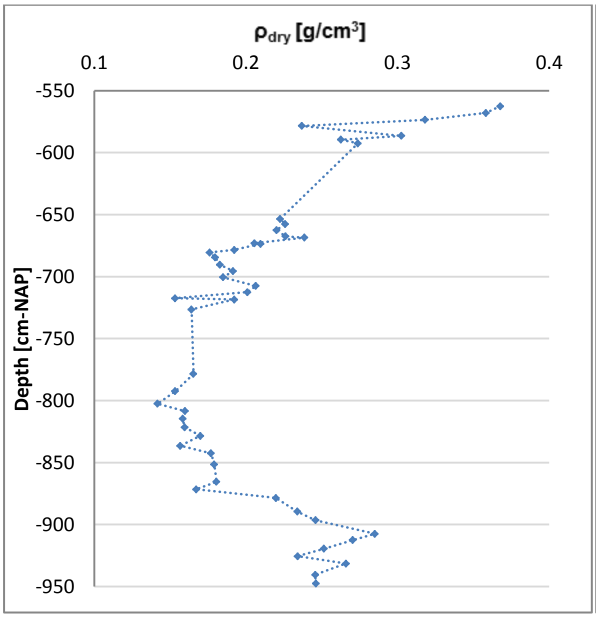

Recent anthropogenic
Historical anthropogenic
Fuvial fill
Fluvial channel
Turbated peat
Upper peat
Depth relative to NAP [m]
-15 - -14
-14 - -13
-13 - -12
-12 - -11
-11 - -10
-10 - -9
-9 - -8
-8 - -7
-7 - -6
-6 - -5
-5 - -4
-4 - -3
-3 - -2
-2 - -1
-1 - 0
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6

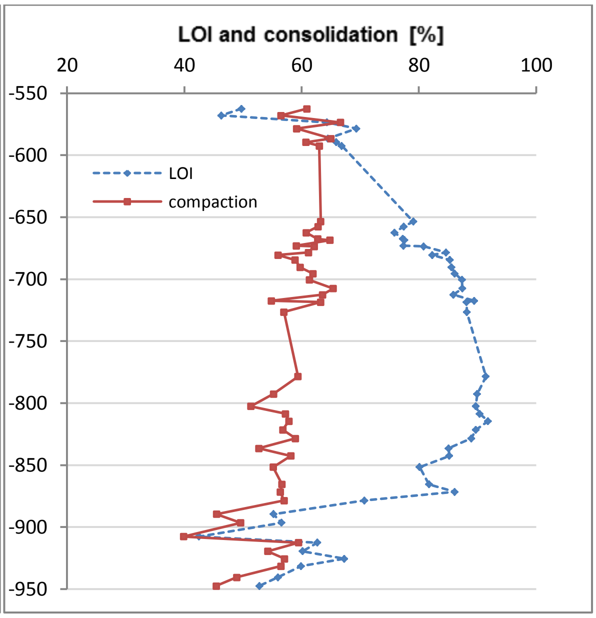

Waddinxveen flood-clay
Lower peat
Holocene floodplain
Holocene channel
Wijchen member
Kreftenheye
Depth relative to NAP [m]
-15 - -14
-14 - -13
-13 - -12
-12 - -11
-11 - -10
-10 - -9
-9 - -8
-8 - -7
-7 - -6
-6 - -5
-5 - -4
-4 - -3
-3 - -2
-2 - -1
-1 - 0
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6

Appendix 10: results from peat sample testing (density and LOI) and consolidation calculations (Van Asselen, 2011).

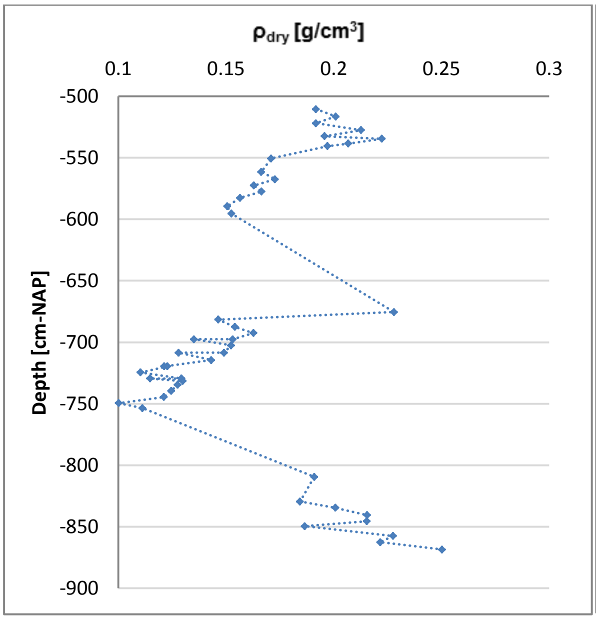
A.

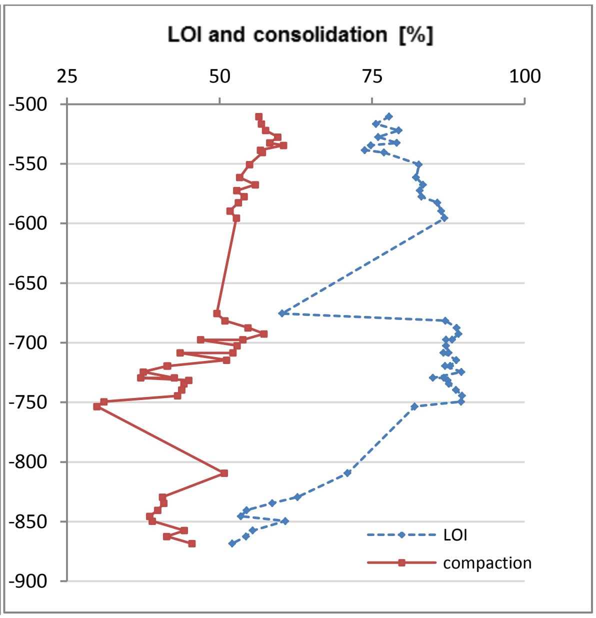
Core B002



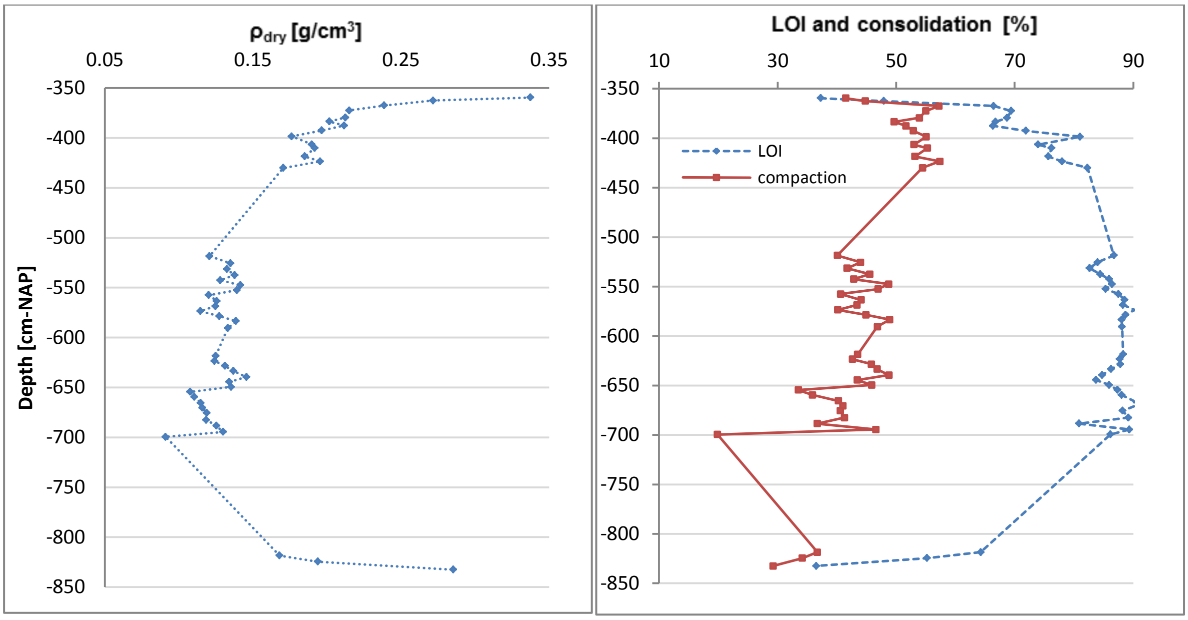


Core B007





Core B009



Core B012